BEACH EROSION CONTROL REPORT ON COOPERATIVE STUDY

SO. KINGSTOWN AND WESTERLY RHODE ISLAND

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

NOV. 13, 1957

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BEACH EROSION CONTROL REPORT ON COOPERATIVE STUDY OF SHORE IN SOUTH KINGSTOWN AND WESTERLY, RHODE ISLAND/

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U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
150 CAUSEWAY STREET
BOSTON 14, MASS.

NEDGW November 13, 1957

SUBJECT: Beach Erosion Control Report on Cooperative Study of Shore in South Kingstown and Westerly, Rhode Island.

TO: Chief of Engineers, Department of the Army, Washington, D. C.

SYLLABUS

This study, made in cooperation with the State of Rhode Island, includes the shore between Point Judith Harbor and Matunuck Point and between Weekapaug Inlet and Watch Hill Point. The purpose of the study is to determine the most suitable method of restoring and stabilizing the shores of Matunuck Beach in South Kingstown and Narragansett and of Misquamicut Beach in Westerly as required in connection with the development of public beaches.

The Division Engineer recommends that the United States adopt projects authorizing Federal participation by the contribution of Federal funds in an amount equal to one-third the first costs of construction of the following projects:

a. Matunuck Beach. - Widening approximately 3,830 feet of beach generally to a 150-foot width by direct placement of about 90,000 cubic yards of suitable sand fill, construction of eight stone groins, each about 260 feet in length, and installation of sand fences.

b. Misquamicut Beach. - Widening about 3,250 feet of beach generally to a 150-foot width by direct placement of about 80,000 cubic yards of suitable sand fill and installation of sand fences.

The Division Engineer further recommends Federal participation to the extent of one-third of the costs of periodic nourishment of the Misquamicut Beach project for a period of 10 years from the year of completion of the initial construction.

The estimated amounts of Federal participation in the first costs of the recommended projects are $94,300 for Matunuck Beach and $46,000 for Misquamicut Beach, and the estimated amount of Federal participation in periodic nourishment costs for Misquamicut Beach is $2,000 annually.

BEACH EROSION CONTROL REPORT ON COOPERATIVE STUDY OF SHORE IN SOUTH KINGSTOWN AND WESTERLY, RHODE ISLAND

I. GENERAL

1. Authority. - The study was made by the Corps of Engineers, United States Army, in cooperation with the State of Rhode Island, Division of Harbors and Rivers of the Public Works Department, under authority of Section 2 of the River and Harbor Act approved July 3, 1930, as amended and supplemented. Formal application for the cooperative study dated October 18, 1955 was approved by the Chief of Engineers on January 5, 1956.

2. Purpose. - The purpose of the study, as stated in the formal application, is to determine the most suitable method of restoring and stabilizing the shores of Matunuck Beach in South Kingstown and Misquamicut Beach in Westerly as required in connection with development of public beaches.

3. Prior Reports. - A cooperative beach erosion control study on the south shore of Rhode Island, which included the two areas under consideration, was completed in 1949 by the Corps of Engineers. The report thereon was printed in House Document No. 490, 81st Congress. No Federal projects were recommended for the areas now under study but it was concluded that artificial placement of fill and a groin system could be used to improve the beach east of Matunuck Point and that placement of a stockpile of sand would be a practicable method of beach building for the reach of shore including Misquamicut and East Beaches.

4. Location. - The study area is located along the south shore of Rhode Island, bordering Block Island Sound, Atlantic Ocean. The two beaches under consideration are approximately 0.7 mile and 0.6 mile in length, located in the towns of South Kingstown and Westerly. The areas are shown on United States Coast and Geodetic Survey Charts No. 248 and 1211; on Army Map Service 7½ minute quadrangles of Kingstown and Watch Hill, Rhode Island; and on maps accompanying this report.

5. Population. - The State of Rhode Island had a population of 791,896 in 1950, an increase of 11 per cent over 1940. Of this total 10,148 resided in the Town of South Kingstown and 12,380 in the Town of Westerly, the two towns increased in population about 14 and 11 per cent between 1940 and 1950. The Rhode Island Development Council in their publication "The Rhode Island Shore" estimated that the Town of South Kingstown would have a population of between 16,000 and 24,000 by 1970 and that the Town of Westerly would increase to between 15,000 and 17,000. Both are resort towns which about double

in population during the summer months. Due to the small size of the state people may drive from any part to these beaches for one day visits. Also many people drive from Massachusetts and Connecticut to use the Rhode Island beaches. The south shore of Rhode Island is served by the New York, New Haven and Hartford Railroad and by U. S. highway No. 1 and R. I. highways No. 2 and No. 3.

6. Description. - Matunuck Beach is a sandy bay-mouth bar with some shingle along its westerly half extending westerly from the west breakwater of Point Judith Harbor of Refuge to Matunuck Point, a distance of about 7,000 feet. The backshore is principally low marsh area bordering Potter Pond. The Jerusalem area near the breakwater is relatively highly developed with summer cottages. From this cluster of cottages to near Matunuck Point the shore is sparsely developed as the hurricanes of 1938 and 1954 swept the cottages from the area. During 1957 the State of Rhode Island acquired about 3,830 feet of shore extending from a point about 885 feet east of Narragansett-South Kingstown town line westward to the beginning of the cottages east of Matunuck Point. The State has revealed plans to develop a State recreational area in this location providing for bathing, fishing, picnicking and boating. These plans include a bathhouse west of Succotash Road with attendant facilities; a children's bathing beach, boat rental facilities and a bait house in Potter Pond. The State and Town of South Kingstown are planning a marina on adjacent property fronting on Point Judith Pond. At the present time an asphalt road parallels the shore from the breakwater to about the center of the State-owned property where it turns north to join U. S. Route 1.

7. The physiographic unit within which the problem area at Misquamicut Beach lies, is a long barrier beach about 5 miles in length extending from Weekapaug Inlet to Watch Hill. The area is rather flat except for a dune up to about 30 feet high at the east end and a low dune located along most of the remainder of the shore. This barrier beach separates Winnapaug and several smaller ponds from the ocean. Public property consists of about 100 feet of frontage owned by the State adjacent to the State jetty at Weekapaug Inlet, and about 400 feet of Town of Westerly frontage at the town beach about 1½ miles west of Weekapaug Inlet. The Town of Westerly is undertaking to obtain under the State's Shore Development Act about 3,250 feet of frontage, located about one-half mile west of the existing town beach, to develop a public beach together with bathhouses, pavilions, parking areas and other facilities. Except for that area the town plans to acquire, the area is rather highly developed with summer homes, privately owned fee beaches, association beaches and various recreational facilities.

8. Statement of the Problem. - The cooperating agency has requested that methods be devised to restore and protect the State's shore property at Matunuck Beach and the proposed Town acquisition at

Misquamicut Beach and the contemplated improvements thereto. Both areas have been eroding and during the 1954 hurricane Misquamicut Beach was breached. The Division of Parks and Recreation suggested that if groins were necessary to protect Matunuck Beach that consideration be given to compartmentation of the area into a single compartment by long jetties that may also be used for fishing. It was also stated that at both beaches alongshore currents cut shelves or escarpments in the beach below low water which create dangerous conditions for inexperienced swimmers and non-swimmers.

II. FACTORS PERTINENT TO THE PROBLEM

9. Geomorphology. - The materials along the south shore of Rhode Island are of glacial deposit. The area under consideration is an outwash plain with the Point Judith headland as its easterly promontory and the Harbor Hill Moraine at Watch Hill as its westerly promontory. The long barrier beaches are apparently the result of distribution of glacial outwash sand by the action of waves and alongshore currents. Bedrock is exposed at Weekapaug Point. See Appendix A for additional information.

10. Littoral Materials. - Littoral materials in the study area are chiefly fine to medium sand with some gravel or shingle especially along the outer ends of embayments. Along the beach berm the median grain size ranges from 0.23 mm to 0.42 mm and is larger along the beach at lower elevations. In the offshore, the materials sampled were medium to coarse sand and gravels. At Matunuck below high water the sand is medium to fine becoming mixed with gravel in the vicinity of Succotash Road. Near Matunuck Point the entire shore is gravel and cobble. Above high water the sand is fine mixed with coarse at the east, growing more coarse to the west until about midway the shore above high water is shingle mixed with a little sand.

11. Eroding headlands of glacial materials which formerly supplied sand to the shores are now protected by structures or boulders remaining after removal of fine materials. They thus presently supply little littoral material. The only natural source of material for beach building is through erosion of adjacent beaches within the physiographic units.

12. Littoral Forces. - The principal littoral forces which affect the problem area are waves, winds and tide. Each is discussed separately in the following sub-paragraphs. More detailed information is presented in Appendix C.

a. Tides. Tides within the study area are semidiurnal in character. The mean and spring ranges are respectively 3.1 and 3.9 feet at Point Judith Harbor and 2.5 and 3.1 feet at Watch Hill.

b. Storm Tides. The maximum storm tides of record occurred during the 1938 hurricane. The elevation was approximately 12 feet above mean sea level at the problem areas. Stages approaching those of 1938 were reached in August 1954. Tidal records for Newport indicate that a tidal stage of 2.5 feet above mean high water occurs about once a year.

c. Winds. Wind records for Block Island, Rhode Island about 8 miles off of the south shore of Rhode Island, indicate that the prevailing winds to which the study areas are exposed are from the southwest. These winds blowing over 25 miles of water in Block Island Sound cause serious wave action along the shore. Winds from the southeast quadrant, although less frequent, are more severe and act over practically unlimited fetches of open sea, causing a maximum of damaging effect for each individual occurrence.

d. Waves. Unrestricted fetch is available from the directions of east-southeast through south-southwest, other directions are offshore or restricted by Martha's Vineyard or Long Island. Waves statistics computed from weather charts for the years 1948 to 1950 indicate that the energy of waves from the southeast and east-southeast is about 70 per cent greater than the energy of waves from the south and southwest.

13. Shore Line and Offshore Changes. - The shore line and offshore depth changes along the south shore of Rhode Island for the period of record since 1839, the date of the earliest reliable surveys, are not as marked as might be expected. The principal reasons for this are believed to be (1) the character of the shore (rocky headlands with intervening relatively short lengths of beach), (2) the fact that the evolutionary processes within the normal tidal ranges, and under water, when comparisons have been made, have reached a rather mature stage, and consequently changes within the rather brief period of historical record are slow and slight, and (3) the level of wave attack during hurricanes has been higher than that most effective in changing the configuration of the shore. If data were available to permit comparisons at storm tide level, more rapid and noteworthy changes would undoubtedly be noted. Available information on changes in the high water shore line and the 6, 12, 18, 24 and 30-foot depth contours prior to 1946 is shown on Plates 7 to 10. Comparisons of the 1946 and 1956 mean high water shore lines from Point Judith west breakwater to Matunuck Point and from Weekapaug Inlet to Watch Hill Point are shown on Plates 2 to 4.

14. Prior to 1946 the Jerusalem shore line showed marked accretion for about 1,000 feet west of the west breakwater at the inlet to Point Judith Pond. This accretion was not as pronounced as might be expected as much of the material passed through the pervious portion of the breakwater into the inlet and the pond. West of the accretion area to Matunuck Point, the shore line and offshore depth contours receded 500 feet or more. In 1950 the inshore portion of the breakwater was made impermeable by addition of sand tight core. Little change in the beach was observed since that date. The survey of 1956 showed additional general recession of the shore line between Matunuck Point and Point Judith Harbor, ranging from about 15 to 40 feet.

15. A slight migration westward is indicated at Weekapaug Inlet by comparison of the 1839 and 1946 surveys. From 1909 to 1946 there was a general recession of the shore line from Weekapaug Inlet to Watch Hill. Since 1946 there was general recession west of Weekapaug Inlet to about profile 14 and slight accretion westward therefrom to Watch Hill. Accretion occurred immediately west of Weekapaug west jetty. Recession occurred thence to a point about 1,000 feet west, the maximum amounting to about 90 feet. The proposed town acquisition area also experienced considerable recession, ranging up to about 70 feet.

16. Existing Structures. - The principal structures affecting shore processes in the study area are the breakwaters at Point Judith Harbor and the jetties at Weekapaug Inlet. The breakwaters at Point Judith were built from 1891 to 1914 and additional work to make the inshore portion of the west breakwater impervious was performed in 1950. The Weekapaug Inlet east and west jetties were built about 1900 and 1954, respectively. In both cases the structures are of stone-mound construction and are in good condition. There are a concrete sea wall and stone revetment at Watch Hill as well as short sections of concrete sea wall in front of properties in the Misquamicut Beach area. The Point Judith breakwaters caused marked accretion for a short distance westward, and the Weekapaug Inlet west jetty caused minor accretion on its west side.

17. Profiles. - At Matunuck Beach the foreshore slopes are relatively steep ranging from about 1 on 9 to 1 on 13 above mean sea level. Below mean sea level to the beginning of the flatter offshore bottom they range from about 1 on 17 to 1 on 27, except at profile 4 where the slope is about 1 on 100 over the bar of cobbles and boulders fronting Matunuck Point. In Westerly the slopes vary more widely. Along the part of the beach above mean sea level the slopes are about as follows: between profiles 5 and 8 from 1 on 20 to 1 on 40; between profiles 9 and 14, from 1 on 8 to 1 on 15; and, at profiles 15 and 17, about 1 on 25. The slopes of portion of the profiles from about mean sea level to the beginning of the flatter offshore bottom generally range from about 1 on 25 to 1 on 45. For detailed information see Appendix B and Plates 5 and 6.

18. Volumetric Accretion and Erosion. - Surveys were not in sufficient detail to accurately determine accretion at Point Judith west breakwater and at Weekapaug west jetty. Computed quantities of erosion or accretion between profiles and amount of recession at each profile occurring between 1946 and 1956 are shown below:

Profile No.	Recession of Mean High Water Line (feet)	Distance Between Profiles	Volume (cubic yards)
1	40		
		1,521	115,000
2	20		
		1,407	144,000
3	15		
		1,435	136,000
4	15		
Total		4,363	395,000
5	50		
		3,400	144,000
6	40		
		1,510	55,000
7	20		
		1,390	14,000
8	20		
		1,410	*15,000
9	40		
		1,400	*14,000
10	30		
		705	0
11	20		
		1,410	5,000
12	50		
		1,430	46,000
13	30		
		2,720	78,000
14	25		
		2,720	12,000
15	0		
		3,900	0
16	30		
Total		21,995	325,000

* figures indicate accretion

III. ANALYSIS OF THE PROBLEM

19. Shore Processes. - The supply of new material to the shore from Point Judith Harbor to Watch Hill has been reduced as glacial till headlands are protected by structures or boulders and cobbles remaining from former erosion. Present supply comes largely from erosion of adjacent beaches. In the prior report it was concluded that the breakwaters at Point Judith sheltered the Jerusalem - Matunuck Point area from southeasterly waves and that the accretion west of the west breakwater indicated a predominantly eastward littoral drift in this area. Although no important additional accretion at the breakwater since 1946 has been observed in spite of work in 1950 to make that structure sand tight, available evidence still supports the conclusion as to the eastward direction of littoral drift at Matunuck Beach. Apparently lack of a sufficient supply of material from the west results in erosion of Matunuck Beach by waves approaching from the west.

20. In the prior report, no conclusive evidence was available as to direction of littoral drift on the shore from Weekapaug Inlet to Watch Hill. The indication of a predominant westward drift by predominance of easterly swells is supported by the greater energy of waves from the east and southeast as determined from computed wave statistics. The greater shore recession and volumetric losses in the eastern than in the western portion of this reach confirm the indication of a predominant westward littoral drift. However, the accretion fillet immediately west of the Weekapaug west jetty indicates that reversals in transport direction occur and it seems likely that the net transport in either direction is relatively small.

21. During the 10-year period from 1946 to 1956, the average annual losses or deficiency in supply at Matunuck Beach amounted to about 40,000 cubic yards, of which about 32,000 cubic yards occurred within the State-owned shore. During the same period the average annual losses from Weekapaug Inlet to Watch Hill were 32,500 cubic yards, of which about 4,000 cubic yards were from the shore which the Town of Westerly plans to acquire. At Misquamicut Beach there appears to be a significant loss by deflation. Due to coarseness of existing material above mean high water at Matunuck Beach it is considered that deflation is a minor item at that location. At both problem areas it is probable that significant volumes of sand have been moved landward across the barrier beaches onto the marshes or into the ponds during hurricanes. If no remedial measures are undertaken it appears that erosion will continue and in both areas the barrier beaches may be breached in the future.

22. Methods of Correcting Problem Conditions. - At both Matunuck Beach and Misquamicut Beach the problem stems from the fact that insufficient material enters the areas to replace losses. Since

beaches are of prime importance the problem may be resolved only by providing material to artificially replace losses. This may be accomplished either by stockpiling suitable sand for natural distribution or by direct placement along the beach. In the two areas considered herein smaller losses will result by direct placement of the sand. At Matunuck Beach erosion losses are large and there appears to be significant easterly predominance in the direction of littoral transport therefore the use of groins must be considered. At Misquamicut Beach the losses are small and the direction of transport is variable with possible significant offshore movement tending to cause flatter offshore slopes. As groins are not effective in reducing offshore losses and the alongshore losses are relatively low in this area, further consideration of groins is not necessary. Sand fences may be used to effect at least partial control of deflation of fill and existing beach materials.

23. Design Criteria. - Proposed protective measures are designed to provide protection against ordinary storms of comparatively frequent occurrence (at least once each year). They are not intended to provide complete protection to waterfront structures in event of a hurricane or exceptional storms of infrequent occurrence, although even under these conditions some protection will be afforded. Specific design criteria used for protective works are as follows:

a. Design Tide. The design tide is the maximum elevation which occurs at least once each year. Tide records at Newport indicate that stages in excess of 2.5 feet above the plane of mean high water occur about once each year.

b. Groins. The horizontal shore section should ordinarily have a top elevation not lower than the general height of berms of existing beaches and a length equal to the berm width of the anticipated beach. In the study area, the top elevation should be approximately 5 feet above the plane of mean high water. Barrier groins which are intended to completely block passage of litteral drift or to reduce it considerably should be higher than the anticipated beach berm. Also in the case of stone groins it is desirable to have the top elevation about 1 foot higher because of the spaces between cover stones. The intermediate sloped section should not be steeper than the slope of the existing foreshore, and should approximately equal the anticipated beach slope. The top elevation of the outer section should generally not be lower than 1 feet above the plane of mean low water. For stone construction, the minimum height of groins should be 3 feet. Groins should be sand tight and firmly anchored at their shore ends to prevent flanking. Groin lengths are generally determined by the shape of the fillet and required width at the updrift end of the space between groins. Stone sizes and side slopes for groins are computed using the Iribarren method as described in Technical Report No. 4 of the Beach Erosion Board entitled "Shore Protection Planning and Design." The design wave used is the maximum wave that can approach, without breaking,

in the depth of water at the groin if the fetch is not a limiting factor. Throughout the study area, such maximum waves can be generated with the available fetch. Blankets of spalls or crushed stone are used under stone groins or jetties to minimize settlement due to scour.

c. Sand Fills. Berm elevations of proposed fills are based on those of existing beach berms. The minimum width of fills is based on widths found to afford protection in the area. Computed volumes of fills are based on slopes similar to existing slopes but fills can be placed initially to a steeper slope and permitted to take a natural slope under wave action. Based on these criteria berm elevations are approximately 5 feet above mean high water and beach widths above mean high water are approximately 150 feet with slopes of 1 on 15 to 1 on 20. Suitable sand for beach fills would have size and gradation characteristics similar to those of the sand components of the existing material on beaches. The annual replenishment quantity is estimated to be about 32,000 cubic yards at Matunuck and 4,000 cubic yards at Misquamicut if no retaining structures are provided. It is estimated that the use of groins at Matunuck Beach would reduce losses by at least 25 per cent, resulting in an annual replenishment quantity of about 24,000 cubic yards. For the purpose of detailed design of beach fills, the investigations of materials on the beaches and in proposed borrow areas given in this report must be supplemented when plans and specifications are being prepared.

IV. PLANS OF IMPROVEMENT

24. General. - The purpose of the study is to determine the most suitable methods of restoring and stabilizing shores at Matunuck and Misquamicut Beaches as required in connection with the development of public beaches. This report therefore develops plans for protection of the 3,830 feet of State-owned beach at Matunuck and the 3,250 feet of Misquamicut Beach to be acquired by the Town of Westerly. Details of design are given in Appendix D.

25. Matunuck Beach. - The basic plan for restoration and stabilization of this beach comprises direct placement of suitable sand along the shore to form a beach generally 150 feet wide at mean high water fronting Succotash Road and the low dunes west thereof, and sand fences to promote dune formation. An alternative plan providing for a system of eight groins to reduce losses of beach material, in addition to the beach fill, is also considered. The groins would each be about 260 feet long. Consideration was given to the suggestion that long jetties incidentally useful as fishing piers be provided to compartment the beach. Such structures would be much more expensive and much more sand fill would be required with two jetties to provide desired protection. No further consideration of such structures for shore protection is desirable. Stabilization of the beach would be effected by periodic nourishment. Without groins the estimated nourishment requirement is 32,000 cubic yards of sand annually. With groins the estimated annual requirement is 24,000 cubic

yards. Dredging experience in Point Judith Pond and its entrance channel indicates that suitable sand for initial fill and subsequent nourishment may be obtained from Point Judith Pond within practicable distance for placement by pipeline dredge.

26. Misquamicut Beach. - The plan of restoration and stabilization of this shore comprises direct placement of suitable sand to form a protective beach generally 150 feet wide at mean high water in front of the existing small dune and sand fences to promote dune formation and reduce deflation from the beach. Stabilization of the beach would be effected by periodic nourishment. The estimated nourishment requirement is 4,000 cubic yards of sand annually. Suitable sand for the beach fill may be obtained from Winnapaug Pond directly behind the beach and placed by pipeline dredge.

27. The foregoing plans of restoration and protection for Matunuck and Misquamicut Beaches would not eliminate damage from unusual storms or hurricanes. However, they would be an integral part of higher protection, since it would be necessary to stabilize the shoreline if further protection were to be provided. The State of Rhode Island should consider effects of unusual storms and design beach facilities to minimize or eliminate the possibility of severe damage. Permanent structures should be elevated, with decking not lower than 15 feet above mean sea level to allow surges to pass beneath with minimum damage, and that as much as possible of the equipment be portable so that it may be moved to a safe location in times of severe storms and hurricanes. At Misquamicut Beach during winter and fall months sand is blown from the beach and dunes and deposited on Atlantic Avenue. In the past it has apparently been the practice to remove the sand and place it in locations other than on the beach. In all cases this sand should be replaced on the beach to minimize nourishment requirements from other sources.

V. ECONOMIC ANALYSIS

28. General. - The economic analyses presented herein for the two areas to be developed as public beaches by the State of Rhode Island and the Town of Westerly. The calculations of benefits assume that the Town of Westerly will acquire ownership of the Misquamicut Beach area and will provide the required facilities to realize the estimated peak attendance. It is also assumed that the State will provide the planned facilities at Matunuck Beach to realize the estimated peak attendance.

29. Estimated First Costs. - Detailed breakdown of costs are given in Appendix E. Given below for the two projects are estimated first costs including engineering, design, supervision and administration. These costs are based on the October 1957 price level.

Estimated First Costs

Matunuck Beach

a.	Beach restoration and sand fences	$164,000
b.	Beach restoration, sand fences and eight stone groins	$283,000

Misquamicut Beach

a.	Beach restoration and sand fences	$138,000

30. In addition to restoring adequate protective and recreational beaches, local interests propose to provide at their own expense bathhouses, parking areas and similar appurtenant items to facilitate recreational use. Such facilities are required for realization of the maximum recreational benefits from the beach developments. Based on costs of similar facilities at other public beaches, it is estimated that the State and Town, respectively will expend about $250,000 for Matunuck Beach and $200,000 for Misquamicut Beach in addition to their shares of costs of beach restoration. These costs are included in first costs to determine the economic justification of proposed plans.

31. Annual Charges. - Interest and amortization charges have been computed using an interest rate of 2.5 per cent on all funds. A useful life of project of 50 years has been assumed in determining amortization charges. These annual charges include interest and amortization on the first costs of the beach facilities, but maintenance and operation of the facilities are not included since it is considered that fees charged for parking and bathhouse use will cover these charges. Estimated annual charges are given below:

	Matunuck		Misquamicut
	Without Groins	With Groins	
Interest	$10,400	$13,300	$ 8,500
Amortization	4,200	5,500	3,500
Maintenance	200	1,200	200
Periodic Nourishment	45,000	34,000	6,000
Total	$59,800	$54,000	$18,200

32. Estimated Benefits. - The estimated benefits include direct damages prevented and recreational benefits. It is considered that development of appurtenant facilities must be accomplished in order that the estimated recreational benefits will result. Peak day beach attendance of 18,000 has been estimated for Matunuck and 13,000 for Misquamicut.

Total attendance is computed from attendance distribution curves developed from daily attendance records at Rocky Neck State Beach in East Lyme, Connecticut for Matunuck Beach and from records of Eastern Point Beach, Groton, Connecticut for Misquamicut Beach. A list of evaluated benefits follows and more detailed information may be found in Appendix E.

Project	Direct Damages Prevented	Recreational Benefits	Total Benefits
Matunuck	$3,400	$71,600	$75,000
Misquamicut	$4,500	$83,700	$88,200

33. Justification. - The estimated annual benefits and costs and the resulting ratios of benefits to costs are summarized below:

Project	Estimated Annual Benefits	Estimated Annual Costs	Ratio of Benefits to Costs
Matunuck			
Without groins	$75,000	$59,800	1.3
With groins	$75,000	$54,000	1.4
Misquamicut	$88,200	$18,200	4.8

34. Allocation of Costs. - Public Law 826, 84th Congress established a policy of Federal aid in the restoration and protection of shores of the United States, its territories and possessions. The maximum Federal share of the costs is one-third of the first cost of construction and applies in the case of publicly owned shores. The shores involved will be eligible for maximum Federal aid of one-third of the first cost of the beach restoration providing that the State of Rhode Island completes its plan of development of Matunuck Beach and that the Town of Westerly completes its plan of acquisition and development of Misquamicut Beach.

35. Public Law 826 also provides that periodic nourishment may be considered construction eligible for Federal aid when it is the most suitable and economical remedial measure. In the case of Misquamicut Beach, it is considered that periodic nourishment is the most suitable and economical method and thus is eligible for Federal participation. In the case of Matunuck Beach, it is considered that groins are required to reduce the rate of loss; therefore periodic nourishment is not the most suitable and economic method and the reduced replenishment requirements of the project including groins are considered maintenance rather than construction eligible for Federal aid. The initial authorization of Federal aid to periodic nourishment of Misquamicut Beach should be limited to a period of 10 years to permit re-evaluation of benefits, methods and techniques.

36. The estimated allocations of cost of beach restoration and stabilization are as follows:

	First Cost			Periodic Nourishment		
	Federal	Non-Federal	Total	Federal	Non-Federal	Total
Matunuck						
Without groins	$54,700	$109,300	$164,000	$15,000	$30,000	$45,000
With groins	$94,300	$188,700	$283,000	-	$34,000	$34,000
Misquamicut	$46,000	$ 92,000	$138,000	$ 2,000	$ 4,000	$ 6,000

37. Coordination with Other Agencies. - Close coordination has been maintained throughout the study with the Division of Harbors and Rivers, Rhode Island Department of Public Works, the cooperating agency. Local people have been contacted and problems were discussed during inspections of the area. The cooperating agency concurs in the findings and recommendations contained in this report. It considers the report satisfactory and that the proposed plans of protection and improvement are desirable and necessary. Local interests should be required to:

a. Assure maintenance and periodic nourishment of the protective and improvement measures during their useful life as may be required to serve their intended purpose;

b. Provide appurtenant facilities to the extent that anticipated recreational benefits will be realized;

c. Provide, at their own expense, all necessary lands, easements and rights-of-way;

d. Assure that water pollution that would endanger the health of bathers will not be permitted;

e. Assure continued public ownership of the shores and their administration for public use during the economic life of the projects;

f. Obtain approval of the Chief of Engineers prior to commencement of work on a project of detailed plans, specifications and arrangements for prosecuting the work on that project.

VI. CONCLUSIONS AND RECOMMENDATIONS

38. Conclusions. - The Division Engineer concludes that the following are practicable plans for protection and improvement of Matunuck and Misquamicut Beaches.

a. Matunuck Beach. - Widening about 3,830 feet of beach generally to a 150-foot width by direct placement of about 90,000 cubic yards of suitable sand fill, construction of eight stone groins, each

about 260 feet in length and installation of sand fences; periodic nourishment by placement of suitable sand at an estimated rate of 24,000 cubic yards annually.

b. Misquamicut Beach. - Widening about 3,250 feet of beach generally to a 150-foot width by direct placement of about 80,000 cubic yards of suitable sand fill and installation of sand fences; periodic nourishment by placement of suitable sand at an estimated rate of 4,000 cubic yards annually.

39. The projects are economically justified by evaluated public benefits. These benefits warrant maximum one-third participation by the United States in the first cost of construction in accordance with the provisions of Public Law 826, 84th Congress, providing suitable appurtenant facilities are provided to extent that the benefits may be realized. It is advisable for the United States to adopt projects authorizing Federal participation to the extent of one-third the first costs of projects for Matunuck Beach and Misquamicut Beach, and of periodic nourishment costs for Misquamicut Beach.

40. Recommendations. - The Division Engineer recommends that the United States adopt projects for Matunuck Beach and Misquamicut Beach, Rhode Island, authorizing Federal participation by contribution of Federal funds in amount equal to one-third the first costs of the following plans generally as shown on Plate 11:

a. Matunuck Beach. - Widening about 3,830 feet of beach generally to a 150-foot width by direct placement of about 90,000 cubic yards of suitable sand fill, construction of eight stone groins, each about 260 feet in length and installation of sand fences.

b. Misquamicut Beach. - Widening about 3,250 feet of beach generally to a 150-foot width by direct placement of about 80,000 cubic yards of suitable sand fill, and installation of sand fences.

The Division Engineer further recommends Federal participation to the extent of one-third of the costs of periodic nourishment of the Misquamicut Beach project for a period of 10 years from the year of completion of the initial construction.

41. The recommended Federal participation is subject to the conditions that local interests will:

a. Assure maintenance and periodic nourishment of the protective and improvement measures during their useful life as may be required to serve their intended purpose.

b. Provide suitable appurtenant facilities to the extent necessary for realization of evaluated benefits:

c. Provide at their own expense, all necessary lands, easements and rights-of-way;

d. Assure that water pollution that would endanger the health of bathers will not be permitted;

e. Assure acquisition of shore at Misquamicut Beach by a public agency and continued public ownership of the shores and their administration for public use during the economic life of the projects;

f. Obtain approval of the Chief of Engineers prior to commencement of work on a project, detail plans, specifications and arrangements for prosecuting the work on that project.

42. The estimated amounts of Federal participation in the first costs of the projects, in accordance with the foregoing recommendations, are $94,300 for Matunuck Beach and $46,000 for Misquamicut Beach, and the estimated amount of Federal participation in periodic nourishment costs for Misquamicut Beach is $2,000 annually.

ALDEN K. SIBLEY
Brigadier General, U. S. Army
Division Engineer

APPENDIX A

GEOLOGY

1. Geology. - The shore of Rhode Island is one of glacial deposit. At the end of the glacial epoch, the terminal moraine and other materials which had been deposited by the ice sheet as a mantle over the bedrock were partially submerged, leaving an irregular shore line with protruding headlands of glacial material. The present shore line was formed principally as a result of the action of winds and waves on this material. This action resulted along the Rhode Island south shore in the development of the bay-head Scarborough Beach, and of extensive beaches and dunes on bay mouth bars between the headlands, along the tombolo formation of Napatree Beach and on the sandspit of Sandy Point.

2. The most prominent feature along the Rhode Island south coast is the terminal moraine which trends northeastward from Watch Hill Point toward Narragansett Pier. This moraine is a continuation of the Inner, or Harbor Hill, moraine of Long Island. It is commonly accepted as marking the maximum advance of the continental ice sheet during the last stage of glaciation. It consists chiefly of tan-colored clay containing many pebbles and boulders and irregular patches of roughly stratified sand. The moraine is easily recognized and is a distinct feature along the coast. Northward the covering of glacial materials is more irregular in distribution and thickness. South of the moraine are the thin layers of the glacial outwash plain which were deposited by streams flowing from the melting ice. This thin covering is composed of roughly stratified sands and gravels with some beds of large cobbles.

3. Behind the beach and dune areas are partly enclosed salt-water ponds and marsh areas. The beaches are, in general, fairly stable insofar as their movement landward toward the marsh and lagoon area is concerned. Such movement is governed to a certain extent by the further erosion of the protruding headlands, such as Point Judith, Matunuck, Green Hill, Quonochontaug, Weekapaug, Watch Hill, and Napatree Points.

4. Point Judith is composed of easily erodible till but is protected against all but extreme water heights by cobble and boulder paving, the residue of former erosion. Between Black Point and Narragansett Pier, granite bedrock outcroppings stabilize the shore line. Toward Narrow River these outcrops are partly of softer sedimentary rocks such as sandstone and conglomerate which are of the same age as the granites but which erode more easily. The till covering along this shore is generally thinner than to the north and west, and it is generally less clayey than farther inland. It is composed almost wholly of roughly stratified sand and gravel with some cobbles and boulders. It is distributed partly in so-called frontal moraines which trend generally north-south. They are irregular and not too distinct and are not to be confused with the prominent east-west trending Harbor Hill moraine.

5. Matunuck and Green Hill Points are composed of easily eroded till, but are protected within the normal range of wave attack by cobbles and boulders left from former erosion. Quonochontaug and Weekapaug Points are composed of the underlying granitic bedrock and of cobbles and boulders, the residue of former erosion, and are therefore quite resistant to erosive action. Watch Hill Point is composed of easily eroded till, and near it are cliffs of stratified sand which can be easily eroded when reached by storm waves. This area is now largely protected from such erosion by extensive works. Napatree Point is also composed of glacial till and of some stratified sands which are easily eroded.

APPENDIX B

DESCRIPTION AND COMPOSITION OF BEACHES

1. General. - Detailed descriptive data and data on composition of shore between Point Judith and Matunuck Point and between Weekapaug Inlet and Watch Hill Point were obtained from field inspection, field surveys, ground and aerial photographs, topographic maps and coast charts and from discussion with and information furnished by officials of the State of Rhode Island and the towns involved. The area was inspected on August 27 and 28, 1957. The aerial photographs which were used were flown by the Air Force in December 1956. Profiles are shown on Plates 5-6.

2. Profiles. - Seventeen profiles were made, four along Matunuck Beach (profiles 1 through 4), and thirteen along Misquamicut Beach (5 through 17). Beach slopes above high water ranged generally between 1 on 10 to 1 on 25 and the flatter slopes below high water ranged generally from about 1 on 25 to 1 on 35. Table B-1 shows beach slopes at each profile. The locations of the profiles are shown on Plates 2-4.

3. Beach Samples. - Samples of beach material were taken at the beach berm, mid-tide elevation and the 6, 12, 18, 24 and 30-foot depths along profiles 2, 3, 7, 9, 11 and 13, and in Potter, Winnepaug and Mashaug Ponds. Table B-2 shows the median diameter and the gradation in grain size of each sample. The analysis indicates that generally the sand at mid-tide and above is fine while below mid-tide the sand falls generally in the medium classification. Some gravel is generally found in the samples taken below the mid-tide elevation. The locations of the sampling are shown on Plates 2-4.

Table B-1 - Beach Slopes

Profile No.	Elevation: Feet above MSL	Slope	Elevation: Feet above MSL	Slope
1	6 to 2	1 on 4	2 to -5	1 on 27
2	8 to 2	13	2 to -13	19
3	8 to 1	9	1 to -10	17
4	8 to 1	13	1 to -4	100
5	8 to 4	20	4 to -8	36
6	8.5 to 5	30	5 to -9	17
7	9.5 to 6.5	40	6.5 to -8	25
8	6 to 2	25	2 to -6.5	45
9	5 to -1	14	-1 to -7	37
10	7.5 to 1	15	1 to -8.5	29
11	10 to 1	8	2 to -8	25
12	-	-	7 to -7	29
13	5.5 to 1	11	1 to -8	32
14	6 to -1	10	-1 to -7	35
15	8 to 5	26	5 to -10.5	11
17*	-	-	-2 to -10	25

* Toe of revetment fronting sea wall about elevation -2 feet

TABLE B-2 ANALYSIS OF SAND SAMPLES

Location	Elevation in feet	Median Diameter in mm	Per cent Fine Sand .074-0.42 mm	Per cent Med. Sand 0.42-2.0 mm	Per cent Coa. Sand 2.0-4.7 mm	Per cent Gravel over 4.7 mm
Profile 2	Berm	0.25	84	16	---	---
	Mid tide	0.27	88	12	---	---
	-6	1.9	2	50	14	34
	-12	1.3	6	52	7	35
	-18	0.63	24	62	10	4
	-24	0.85	7	62	31	---
	-30	1.16	1	44	15	40
Profile 3	Berm	0.42	36	64	---	---
	Mid tide	3.2	16	21	32	31
	-6	1.6	---	57	18	25
	-12	1.2	1	66	11	22
	-18	0.89	---	67	11	22
	-24	7.9	---	18	13	69
	-30	2.8	1	43	18	38
Profile 7	Berm	0.23	80	18	2	---
	Mid tide	0.20	89	8	3	---
	-6	9.5	---	13	15	72
	-12	0.52	7	93	---	---
	-18	0.55	13	87	---	---
	-24	1.6	55	5	20	20
	-30	1.6	55	8	17	20

Location	Elevation in feet	Median Diameter in mm	Per cent Fine Sand .074-0.42 mm	Per cent Med. Sand 0.42-2.0 mm	Per cent Coa. Sand 2.0-4.7 mm	Per cent Gravel over 4.7 mm
Profile 9	Berm	0.25	85	15	--	--
	Mid tide	0.23	65	30	5	--
	-6	4.4	1	38	14	47
	-12	0.75	6	55	30	9
	-18	1.2	1	76	6	17
	-24	2.7	10	35	12	43
	-30	0.51	7	87	6	--
Profile 11	Berm	0.28	76	24	--	--
	Mid tide	0.24	88	12	--	--
	-6	0.73	19	45	4	32
	-12	6.2	3	40	4	53
	-18	9.8	1	10	13	76
	-24	2.5	--	46	21	33
	-30	1.1	2	55	5	38
Profile 13	Berm	0.41	55	45	--	--
	HW	0.77	13	65	3	19
	-6	2.3	--	46	27	27
	-12	7.5	--	13	20	67
	-18	6.1	--	34	9	57
	-24	0.87	8	58	4	30
	-30	0.86	3	70	3	24
Potter Pond	#1	0.15	100	--	--	--
	#2	0.17	94	6	--	--

Location	Elevation in feet	Median Diameter in mm	Per cent Fine Sand .074-0.42 mm	Per cent Med. Sand 0.42-2.0 mm	Per cent Coa. Sand 2.0-4.7 mm	Per cent Gravel over 4.7 mm
Potter Pond	#3	0.22	90	10	--	--
	#4	0.14	100	--	--	--
	#5	0.14	92	8	--	--
Winnapaug Pond	Inlet	0.23	82	16	2	--
	#4	0.19	94	6	--	--
	#5	0.27	87	13	--	--
	#7	0.45	35	59	6	--
Maschaug Pond		0.18	98	2	--	--
		0.17	98	2	--	--

4. Detailed Description. - Detailed description of the shore is given below in tabular form. Description is in short segments of shore proceeding from east to west. Elevations are referred to the plane of mean sea leve, 1929 datum, unless otherwise specified.

A. Town of Narragansett

(1) Matunuck Beach (East)

a. Location: Point Judith west breakwater to State beach.

b. Shore Length: Approximately 1,500 feet.

c. Beach Width above HW: About 125 feet at breakwater to about 75 feet at west end.

d. Ownership: 100 feet of Town beach, remainder private.

e. Beach Use: Public and residential bathing.

f. Public Facilities: State lifeguard at Town beach.

g. Composition of Shore: Fine sand seaward of berm and fine sand mixed with coarse landward from berm.

h. Protective Structures: Federal stone breakwater at east limit 1,950 feet long, top elevation of 10 feet above MLW, top width 15 feet, side slopes of 1 on 1 at harbor side and 1 on 2 at seaward side.

i. Character of Development: Town beach at east end then summer residences.

(2) Matunuck Beach (State)

a. Location: West from reach (1).

b. Shore Length: Approximately 885 feet.

c. Beach Width above HW: About 90 to 100 feet.

d. Ownership: State of Rhode Island.

e. Beach Use: Public bathing beach.

f. Public Facilities: Lifeguards, picnic tables and trash containers.

g. Composition of Shore: Fine sand below HW becoming mixed with gravel at west end. Fine sand mixed with coarse sand above HW.

h. Protective Structures: None

i. Character of Development: Relatively undeveloped bathing beach.

B. Town of South Kingstown.

(1) Matunuck Beach (West).

a. Location: Town line to cottages east of Matunuck Point.

b. Shore Length: Approximately 2,950 feet.

c. Beach Width above HW: Generally 75 to 100 feet width, extreme narrowing at west end.

d. Ownership: State of Rhode Island.

e. Beach Use: Bathing.

f. Public Facilities: None

g. Composition of Shore: Fine sand with some gravel at about center of reach where there is generally gravel with some fine sand. Shingle above HW throughout.

h. Protective Structures: None

i. Character of Development: None

(2) Matunuck Point.

a. Location: East side of point

b. Shore Length: Approximately 1,250 feet

c. Beach Width above HW: 0 to 5 feet.

d. Ownership: Private

e. Beach Use: Fishing, some bathing at west

f. Public Facilities: None

g. Composition of Shore: Cobble except westerly 300 feet which is sand with shingle. Shingle bar, 200-300 feet long protruding at west end and boulder bar extending out about 100 feet about 300 feet east of west end.

h. Protective Structures: None

i. Character of Development: Summer cottages.

(3) Matunuck Point (West)

a. Location: West from point

b. Shore Length: Approximately 1,000 feet.

c. Beach Width above HW: 5 to 50 feet.

d. Ownership: Private

e. Beach Use: Fishing, some bathing at west end.

f. Public Facilities: None

g. Composition of Shore: Coarse sand behind cobble and boulder bar. Very steep beach slopes.

h. Protective Structures: None

i. Character of Development: Summer cottages.

C. Town of Westerly.

(1) Weekapaug Inlet.

a. Location: West from inlet.

b. Shore Length: Approximately 2,400 feet.

c. Beach Width above HW: About 200 feet at jetty decreasing to about 35 feet at west.

d. Ownership: 100 feet public at jetty, then private.

e. Beach Use: Bathing.

f. Public Facilities: Lifeguard, trash disposal

g. Composition of Shore: Fine sand, 10 to 20-foot dunes behind beach.

h. Protective Structures: Rubble mound jetty at east end protecting inlet.

i. Character of Development: Commercial parking lot at east, expensive to medium summer residences thereon.

(2) Misquamicut Beach.

a. Location: West from reach (1).

b. Length of Shore: Approximately 3,800 feet.

c. Beach Width above HW: 35 to 100 feet fronting dunes.

d. Ownership: Private

e. Beach Use: Residential bathing.

f. Public Facilities: None

g. Composition of Shore: Fine sand.

h. Protective Structures: Scattered stone revetments in front of dunes along narrower parts of beach near easterly end. Short lengths of sand fence scattered along reach.

i. Character of Development: Summer residences.

(3) Misquamicut Beach.

a. Location: West from reach (2).

b. Shore Length: Approximately 1,800 feet.

c. Beach Width above HW: Generally about 45 feet.

d. Ownership: 445 feet Town owned at west limit, remainder private.

e. Beach Use: Bathing.

f. Public Facilities: Closets for clothing change, trash disposal, first aid facilities and parking area for residents only at town beach. No facilities in remainder of reach.

g. Composition of Shore: Fine sand.

h. Protective Structures: Artificial sand dune along town beach.

i. Character of Development: Bathing beach and summer residences.

(4) Misquamicut Beach.

a. Location: West from reach (3).

b. Shore Length: Approximately 1,400 feet.

c. Beach Width above HW: 45 to 50 feet fronting artificial dunes.

d. Ownership: Private

e. Beach Use: Bathing beaches.

f. Public Facilities: Privately owned public fee beaches with bathhouses, parking, eating and other commercial facilities.

g. Composition of Shore: Fine sand.

h. Protective Structures: Scattered low sea walls at commercial beaches.

i. Character of Development: Commercial

(5) Misquamicut Beach (Proposed Taking).

a. Location: West from reach (4).

b. Shore Length: Approximately 3,250 feet

c. Beach Width above HW: 150 feet at east to about 80 feet at west. Beach made wider by making artificial dunes shoreward of dune line farther east.

d. Ownership: Private - State and Town plan to purchase under authority of Rhode Island Shore Development Act of 1956.

e. Beach Use: Bathing where used.

f. Public Facilities: None

g. Composition of Shore: Fine Sand

h. Protective Structures: None

i. Character of Development: Undeveloped (swept clean by 1954 hurricane).

(6) Misquamicut Beach.

a. Location: West from reach (5).

b. Shore Length: Aprroximately 3,800 feet

c. Beach Width above HW: About 80 feet at east gradually decreasing to about 50 feet about 300 feet from west end then decreasing to zero at west end.

d. Ownership: Private

e. Beach Use: Residential and private beach club bathing.

f. Public Facilities: None (private facilities existing).

g. Composition of Shore: Fine sand, at west end mixed with cobble and shingle.

h. Protective Structures: Stone revetment fronting two houses built on foreshore of beach with stone groin about 50 feet long about 300 feet from west end of reach.

i. Character of Development: Beach clubs at east and summer residences at west end. More cheaply constructed cottages behind fronting houses at west end.

(7) Misquamicut Beach.

a. Location: West from reach (6).

b. Shore Length: Approximately 5,100 feet

c. Beach Width above HW: 0 to 200 feet

d. Ownership: Private

e. Beach Use: None

f. Public Facilities: None

g. Composition of Shore: Fine sand to beach berm then shingle landward to pond.

h. Protective Structures: None

i. Character of Development: Undeveloped. Apparently hurricane destroyed all cottages.

(8) East of Watch Hill Point.

a. Location: West of reach (7).

b. Shore Length: About 5,700 feet.

c. Beach Width above HW: Generally 200 to 300 feet.

d. Ownership: Private

e. Beach Use: Residential and hotel bathing.

f. Public Facilities: None

g. Composition of Shore: Fine sand. Some gravel above HW near east end.

h. Protective Structures: Short reaches of sand fence and scattered small revetments fronting houses.

i. Character of Development: Generally large estates and one hotel.

(9) East of Watch Hill Point

a. Location: Adjacent to Watch Hill Point.

b. Shore Length: About 670 feet.

c. Beach Width above HW: 5 feet to 0.

d. Ownership: Private

e. Beach Use: Residential

f. Public Facilities: None

g. Composition of Shore: Fine sand below revetment.

h. Protective Structures: Approximately 600 feet of concrete sea wall with stone toe protection. Rough stone revetment to about elevation 40 feet behind sea wall.

i. Character of Development: Large estates constructed at end of eroded moraine.

APPENDIX C

LITTORAL FORCES

1. Tides. - Mean tidal range values in the general area published by the Coast and Geodetic Survey follow in Table C-1.

Table C-1 - Tidal Differences and Ranges

Location	Differences *			Ranges in feet	
	Time		HW	LW	Mean	Spring
	h	m				
Newport, R. I.	-		-	-	3.5	4.4
Pt. Judith Harbor	≠0	10	-0.4	0.0	3.1	3.9
Block Island (Great Salt Pond)	≠0	10	-0.9	0.0	2.6	3.2
Block Island Harbor	0		-0.6	0.0	2.9	3.6
Watch Hill Point	≠0 ≠1	35 (h) 25 (l)	-1.0	0.0	2.5	3.1

*Referred to Newport, Rhode Island
(h) Difference for high waters only
(l) Difference for low waters only

For the prior report on south shore of Rhode Island (see paragraph 3 of this report) tidal observations for one tidal cycle were taken at various ponds along the shore in August 1945. The results of these observations, adjusted to mean values, are shown in Table C-2.

Table C-2 - Mean Tidal Ranges in Feet

Pond	Ocean	Inlet	Pond
Point Judith	3.1	3.0	3.0
Charlestown	2.8	1.4	0.2
Quonchontaug	2.7	1.8	0.2
Winnapaug	2.6	1.5	0.5

2. Storm Tides. - In beach erosion control studies principal consideration is given to mean and spring tides. In Rhode Island, however, large damage has occurred due to excessive tides generated by hurricanes and other intense storms. Table C-3 contains available information on maximum water elevations induced by storm action.

Table C-3 - Storm Water Elevations in Feet

Location	1938	1954
Point Judith	12.8	12.2
Matunuck	12.2	11.9
Charlestown	11.9	11.5
Misquamicut	11.8	11.3
Watch Hill	10.4	9.7

During the northeast storm of November 6-7, 1953 it was reported tide heights along the Rhode Island Coast were generally from 2.5 to 4 feet above predicted tides.

3. Study was made of about 7 years of tidal observations at Newport by the United States Coast and Geodetic Survey covering the periods of January 1, 1939 to December 31, 1942; July 1, 1943 to December 31, 1945; and, January 1, 1947 to June 31, 1947. Newport being about 10 miles northeast of Point Judith, is considered to have approximately the same tidal characteristics as the study area, even though the mean high water tide elevation at Point Judith is 0.4 feet lower and at Watch Hill Point is 1-foot lower. Table C-4 shows the number of occurrences in which tides exceeded mean high water during the seven year period and the increments of elevation of exceedence.

Table C-4 - Tides Exceeding Mean High Water at Newport, R. I.

Feet in Excess of MHW	Occurrences*	Feet in Excess of MHW	Occurrences*
1.0 - 1.9	941	2.9	3
2.0	55	3.0	3
2.1	35	3.1	3
2.2	24	3.2	2
2.3	15	3.3	2
2.4	9	3.4	1
2.5	5	3.5	1
2.6	4	3.6	1
2.7	4	3.7	1
2.8	3	3.8	1

*Number of times increment of height was exceeded.

The above table, as stated previously, is based on observations of three periods of time which do not include the hurricanes of 1938, 1944 and August and September 1954. Therefore it is possible that several higher elevations have occurred that do not show in the tabulation. During hurricane "Carol" of August 1954 an elevation of 11.6 feet was reported, which is 7.1 feet above mean high water.

4. Winds. - United States Weather Bureau wind records for the station at Block Island, Rhode Island for the period 1921 through 1939 were used in preparing the wind rose shown on Plate 1. The storm wind diagram which surrounds the rose was prepared from 10 years of record, 1936 through 1945, which includes the hurricanes of 1938 and 1944. The study area is exposed to waves from about west to east-northeast. The wind rose indicates a preponderance of winds from the southwest. These winds blowing over fetches of about 25 miles of water in Block Island Sound cause serious wave action along the shore. Winds from the southeast quadrant, although relatively infrequent, are very severe and act over a practically unlimited fetch of open sea, causing a maximum of damaging effect for each individual occurrence.

5. Winds of maximum average velocity occur from the northwest, or offshore in the study area. From the direction of maximum duration, the average annual velocity of the winds is about 16.1 miles per hour. Therefore the shore is exposed to a significant amount of wave action from the southwest. Characteristics of the winds recorded at Block Island during the period of 1921 through 1939 are given in Table C-5.

Table C-5 - Wind Data - Block Island, Rhode Island

Direction	Average Annual Velocity, MPH	Percent of Total Duration		Percent of Total Movement	
		Percent	Percent Per Degree	Percent	Percent Per Degree
N	16.1	9	0.20	9	0.20
NE	18.0	9	0.20	10	0.22
E	14.2	7	0.16	6	0.13
SE	13.2	6	0.13	5	0.11
S	13.2	13	0.29	10	0.22
SW	16.1	23	0.51	22	0.49
W	17.6	18	0.40	19	0.42
NW	20.9	15	0.33	19	0.42

6. Storms. - According to local interests storms from the southeast and southwest appear to cause greatest damage to the shore. This storm damage includes not only damage to onshore structures and erosion of land above the high water line, but also the cutting of shelves in the beach below high water which causes sharp changes in water depth creating a hazard to bathers. This "shelf" condition exists until less steep waves regrade the beach. As indicated in paragraph 5, a compilation of occurrence of storm winds above 32 miles per hour, was made for Block Island for the 10-year period 1936-1945. The results of this compilation are shown in Table C-6.

Table C-6 - Average Annual Occurrence of Winds Over 32 Miles Per Hour at Block Island, Rhode Island

Velocity in MPH	Average Annual Number of Occurrences								
	N	NE	E	SE	S	SW	W	NW	Total
32-40	8.6*	11.5	6.3	4.5	2.5	3.2	11.6	32.8	81.2
41-50	2.8	4.2	2.0	1.5	0.6	0.3	2.6	9.1	23.1
51-60	0.9	1.7			0.1		0.2	0.6	3.8
61-70								0.1	0.3
71-80									0.2
81-90				0.2					0.2

*Occurrence of winds of specified velocity or greater.

It may be noted that the predominant direction of storms is from northwest or offshore with respect to the study areas. The two occurrences of winds of 81 to 90 miles per hour were during the 1938 and 1944 hurricanes. While hurricanes inflict heavy damages on shore structures and probably intense damage to the beaches, their frequency of occurrence is rare when compared to storms of lesser intensity. Therefore it is considered that principal beach damage is due to the more frequent storms of less than hurricane

intensity. However, as an indication of their seriousness, the evaluated property damage resulting from the 1938 and 1954 hurricanes are presented.

1938	Westerly	$1,400,000
	South Kingstown	700,000
1954	Westerly	$2,000,000
	South Kingstown	2,700,000

7. Waves. - The only wave observations known to have been made in the general area were taken off the south side of Cuttyhunk Island, Massachusetts, between July 1946 and May 1947, by personnel of Woods Hole Oceanographic Institution and reported on in a paper published by Massachusetts Institute of Technology and Woods Hole Oceanographic Institute, entitled "Results of Research on Surface Waves of the Western North Atlantic", by H. R. Seiwell. The gaging equipment used was somewhat experimental in nature and the observations were relatively few in number. Table C-7 gives a summary of wave height statistics as presented in this report.

Table C-7 - Summary of Wave Height Characteristics (in feet)

	SPRING	SUMMER	AUTUMN
Mean	3.5	3.2	4.9
25 per cent cumulative occurrence	0 to 1.5	0 to 1.5	0 to 1.8
50 " " "	0 to 2.8	0 to 2.5	0 to 2.9
75 " " "	0 to 4.9	0 to 3.9	0 to 7.3
95 " " "	0 to 9.0	0 to 9.5	0 to 14.5
Highest wave of each season	16	15	22

8. Wave statistics computed from 3 years of synoptic weather charts (1948-1950) are given in the Beach Erosion Board's Technical Memorandum No. 55, entitled "North Atlantic Coast Wave Statistics Hindcast", by Bretschneider, Revised Sverdrup-Munk Method. Table C-8 contains a summary of these data computed for a station off Nauset Beach, Cape Cod, Massachusetts which is the station considered to have wave characteristics similar to those in the study area. Table C-9 contains computed wave energy data for Nauset Station and a station off New York Harbor entrance, southwest of the study area. These data are of deep-water waves and are for a station located at a point of greater exposure than the study area. In general the fetch at Matunuck and Misquamicut is as follows: from the east the fetch is limited to 40 to 60 miles by Martha's Vineyard; from the southwest to about 25 miles by Long Island, and from east-southeast to south-southwest the coast is exposed to the open sea.

Table C-8 - Average Annual Duration of Waves of Various Heights and Directions in Hours Per Year

Wave Height in Feet	ENE	E	ESE	SE	SSE	S	SSW	SW	Total
25-30	0*	4		1					14
20-25	38	12	1	3					54
18-20	45	21	3	4			4	4	81
16-18	83	44	8	8			7	5	155
14-16	127	76	15	13	3	4	9	12	259
12-14	200	113	25	21	5	16	12	20	412
10-12	293	176	53	32	27	41	23	39	684
8-10	447	284	83	56	67	60	49	79	1,125
6-8	697	472	177	84	117	125	101	153	1,926
4-6	1,183	759	272	173	213	196	188	247	3,231
2-4	2,043	1,349	457	301	315	313	296	324	5,398
0.5-2	2,908	2,268	675	403	384	381	365	345	7,729

*Duration is the number of hours that waves of the specified height or higher occurred from specified direction.

Table C-9 - Average Annual Wave Energy

Direction from which Waves approach	Amount in foot-pounds per foot of crest x 10^9	
	Nauset	New York
ENE	118	100
E	56	49
ESE	16	12
SE	11	13
SSE	11	12
S	11	8
SSW	9	2
SW	10	-
Total	242	196

Therefore, the portions of Tables C-8 and C-9 pertaining to the directions between east-southeast and south-southwest are applicable and waves from other directions would not reach the study area.

APPENDIX D

DESIGN ANALYSIS

1. General. - The design used in this report generally follows methods prescribed in Beach Erosion Board Technical Report No. 4, "Shore Protection Planning and Design", with experience data of the general area influencing the results used. The design criteria used are given in paragraph 23 of the main report.

2. Design elevations were determined as follows:

a. Design tide. - A design tide of 2.5 feet above mean high water was used. This is the maximum elevation occurring with an average frequency of once each year.

b. Design wave. - The design wave is the maximum that can reach the structure, without breaking, at design tide elevation. The height of the design wave is equal to depth at the designated location divided by 1.28. The following design wave heights were used for the groins at Matunuck Beach:

Groin	Wave height in feet at seaward end	Wave height in feet 100' shoreward of end
1-2	8.3	5.9
3-6	9.1	6.7
7-8	11.	7.1

c. Beach berm elevation. - Berm elevations were determined from berm elevations in the general vicinity of the study area. A berm elevation of 5 feet above mean high water, or 6.5 feet above mean sea level, was used in the report. A beach width of 150 feet as that necessary to give adequate protection was also determined from experience in the area.

3. Groin Spacing. - A groin spacing of 500 feet with the 260-foot groin length was determined by the angle with the shore line formed by accretion west of Point Judith Harbor west breakwater.

4. Stone Size. - Size of stone required was determined by applying the design wave heights given in paragraph 2, a stone density of 160 pounds per cubic foot (specific gravity of 2.50) and a K' value of 0.017 to Plate D-6 of Beach Erosion Board Technical Report No. 4, "Shore Protection Planning and Design". The method indicated that the following stone sizes placed on a slope of 1 on 2 would be adequate.

Groin	Stone Size in Tons	
	Outer 100 feet	Inner 160 feet
1-6	4-6	2-4
7-8	6-10	2-6

Experience with the breakwaters at Point Judith Harbor and the jetties at Charlestown and Weekapaug has indicated the need of large stone size to provide stability in the area. Therefore the values obtained from Plate D-6 are used as minimum sizes and the maximums are increased according to offshore conditions.

5. Sand Fence. - Estimates of costs in the report for the fence is based on a double line of fence with 10-foot spurs at 100-foot intervals along the entire reaches, except for entrance openings at convenient points. This is based on the limited experience gained in similar locations in the study of dune building by the University of Rhode Island for the State of Rhode Island. It is suggested that the design be reviewed at the time of construction as additional and more conclusive data should be available from this continuing study at that time.

APPENDIX E

ECONOMIC ANALYSES

Estimated First Costs and Annual Charges

1. First costs include the cost of beach facilities since benefits to be derived depend upon development of the beaches to facilitate usage. The costs of beach improvement and of beach facilities are given separately since only beach restoration and stabilization are eligible for Federal participation, beach facilities are a responsibility of local interests. Estimated costs of facilities, furnished by the State of Rhode Island, are not the result of an engineering estimate but are based on costs of similar facilities at other beaches. Maintenance and operation of beach facilities were not included in the annual charges since it is considered that fees collected for use of parking areas and bathhouses will pay these costs. First costs are based on price level of October 1957 and unit prices are estimated from results of recent bids on projects in the New England area. An interest rate of 2.5 per cent and amortization on the basis of 2.5 per cent for a project life of 50 years is used. Details of the plans are shown on Plate 11.

A. Matunuck Beach (With Groins)

1. First Costs

Beach Fill, 90,000 cubic yards of sand @ $1.35	$121,500
Groins, 13,400 tons of stone @ $7.00	93,500
Sand Fence, 7,700 linear feet	7,000
Contingencies	33,000
Total Contract Cost	$255,000
Engineering and Design	8,000
Supervision and Administration	20,000
Total First Cost of Beach Improvement	$283,000
Total First Cost of Beach Facilities	$250,000
Total First Cost	$533,000

2. Annual Charges

Interest	$ 13,300
Amortization	5,500
Maintenance (groins and fence)	1,200
Beach Replenishment, 24,000 cubic yars of sand @ $1.40	34,000
Total Annual Charges	$ 54,000

B. Matunuck Beach (Without Groins)

1. First Costs

Beach Fill, 90,000 cubic yards of sand @ $1.35	$121,500
Sand Fence, 7,700 linear feet	7,000
Contingencies	19,500
Total Contract Cost	$148,000
Engineering and Design	4,000
Supervision and Administration	12,000
Total First Cost of Beach Improvement	$164,000
Total First Cost of Beach Facilities	$250,000
Total First Cost	$414,000

2. Annual Charges

Interest	$ 10,400
Amortization	4,200
Maintenance	200
Periodic Nourishment, 32,000 cubic yards of sand @ $1.40	45,000
Total Annual Charges	$ 59,800

C. Misquamicut Beach

1. First Costs

Beach Fill, 80,000 cubic yards of sand @ $1.25	$100,000
Sand Fence, 6,500 linear feet	7,000
Contingencies	16,000
Total Contract Cost	$123,000
Engineering and Design	4,000
Supervision and Administration	11,000
Total First Cost of Beach Improvement	$138,000
Total First Cost of Beach Facilities	200,000
Total First Cost	$338,000

2. Annual Charges

Interest	$ 8,500
Amortization	3,500
Maintenance (fence)	200
Periodic Nourishment, 4,000 cubic yards of sand @ $1.50	6,000
Total Annual Charges	$ 18,200

Estimate of Benefits of Improvements

2. General. - All benefits evaluated are non-Federal public benefits and result from preventing damages and providing recreation. At both beaches, it is considered that facilities such as parking areas and bathhouses must be provided before all evaluated benefits may be realized. Benefits to be obtained from the use of sand fence are not

evaluated. Experiments now underway by the State of Rhode Island and the University of Rhode Island indicate that sand fences properly constructed in areas where fine sand exists may be very effective in dune building. At Misquamicut Beach fine sand now exists and the fill material will also be fine; therefore, it appears that significant benefit will result. At Matunuck Beach the existing sand is too coarse for effective use of sand fence, but when sand fill is added, benefit will result.

3. Matunuck Beach. - Recession of the high water line has averaged 4 feet per year at profile 1, 2 feet at profile 2, 2 feet at profile 3 and 1.5 feet at profile 4; therefore, the loss of beach is (585 x 4) + (3 x 1521) + (1407 x 1.75) + (317 x 1.5) = 9,841 square feet per year valued at $0.35 per square foot results in a loss of $3,400 per year. Due to overcrowding of existing beaches it is assumed that all area provided will be used at least once each year. A beach area of about 674,000 square feet is provided by the project, which at 75 square feet per person would accommodate 9,000 visitors. Considering a turnover of 2, a peak day of 18,000 visitors is assumed. Assuming a bathing season of 95 days per year and basing attendance on the records of Rocky Neck Beach, East Lyme, Connecticut, which is similar in size and type to that planned for Matunuck Beach, the following annual attendance is derived.

Per cent of Time	No. of Days Per Year	Per cent of Peak Attendance	Visits
20	19	2	6,800
25	23.8	5.6	23,800
25	23.8	12.8	54,700
15	14.3	24.3	63,000
5	4.7	34	28,600
3	2.7	43	20,400
7	6.7	74	89,000
100	95		286,300

Based on a benefit of $0.25 per visit the recreational benefit would be $71,600 per year. Given below is a summary of benefits evaluated for Matunuck Beach.

	Annual Benefit
Elimination of Land Loss	$ 3,400
Recreation	71,600
Total Annual Benefit	$75,000

4. Misquamicut Beach. - The mean high water line at Misquamicut Beach has been receding at about the following annual rates: 3 feet at profile 10, 2 feet at profile 11, 5 feet at profile 12 and 3 feet at profile 13. Therefore, the average annual area loss is: (105 x 3)

+ (705 x 2.5) + (1410 x 3.5) + (1030 x 4) = 11,125 square feet. At a value of $0.40 per square foot the damage would be $4,500 per year. At this location 487,000 square feet of beach would be provided by the project, which if 75 square feet per person is allowed would accommodate 6,500 visitors. Considering a turnover of 2, a peak day of 13,000 visitors is assumed. Assuming a bathing season of 95 days per year and basing attendance on records of Eastern Point Beach, Groton, Connecticut, which is similar in size and type to that planned for Misquamicut Beach, the following annual attendance is derived:

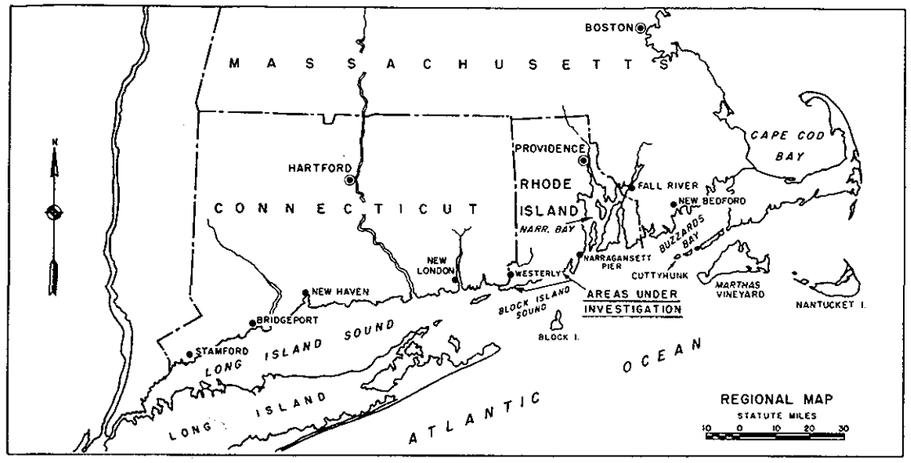
Per cent of Time	No. of Days Per Year	Per cent of Peak Attendance	Visits
25	23.8	3.25	10,000
15	14.3	8.5	15,700
40	38	27	133,000
10	9.5	59.7	73,600
10	9.5	83	102,700
100	95		335,000

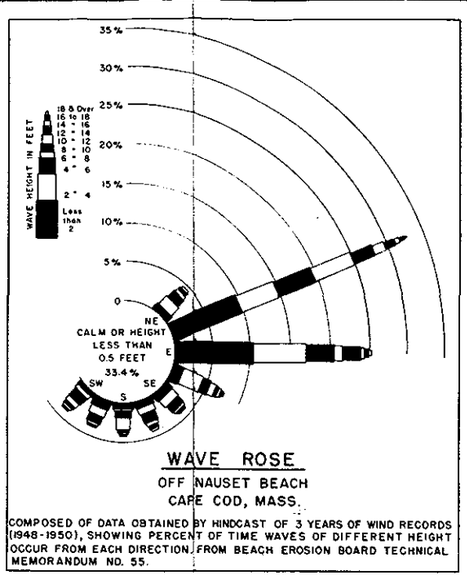
Based on a benefit of $0.25 per visit, the recreation benefit would be $83,700 per year. Given below is a summary of annual benefits evaluated for Misquamicut Beach:

	Annual Benefit
Elimination of Land Loss	$ 4,500
Recreation	83,700
Total Annual Benefit	$88,200

CORPS OF ENGINEERS

U. S. ARMY



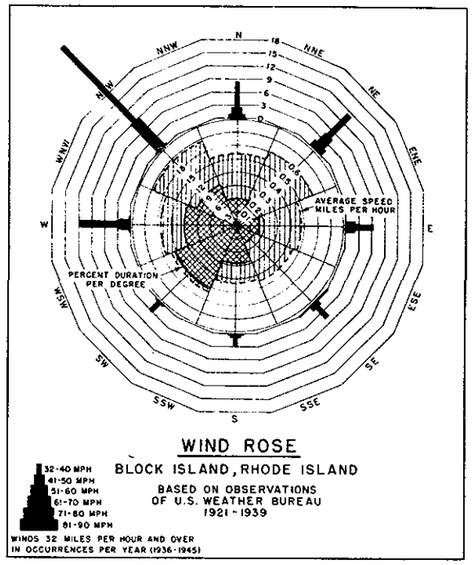


WAVE ROSE

OFF NAUSET BEACH

CAPE COD, MASS.

COMPOSED OF DATA OBTAINED BY HINDCAST OF 3 YEARS OF WIND RECORDS (1948-1950), SHOWING PERCENT OF TIME WAVES OF DIFFERENT HEIGHT OCCUR FROM EACH DIRECTION. FROM BEACH EROSION BOARD TECHNICAL MEMORANDUM NO. 55.

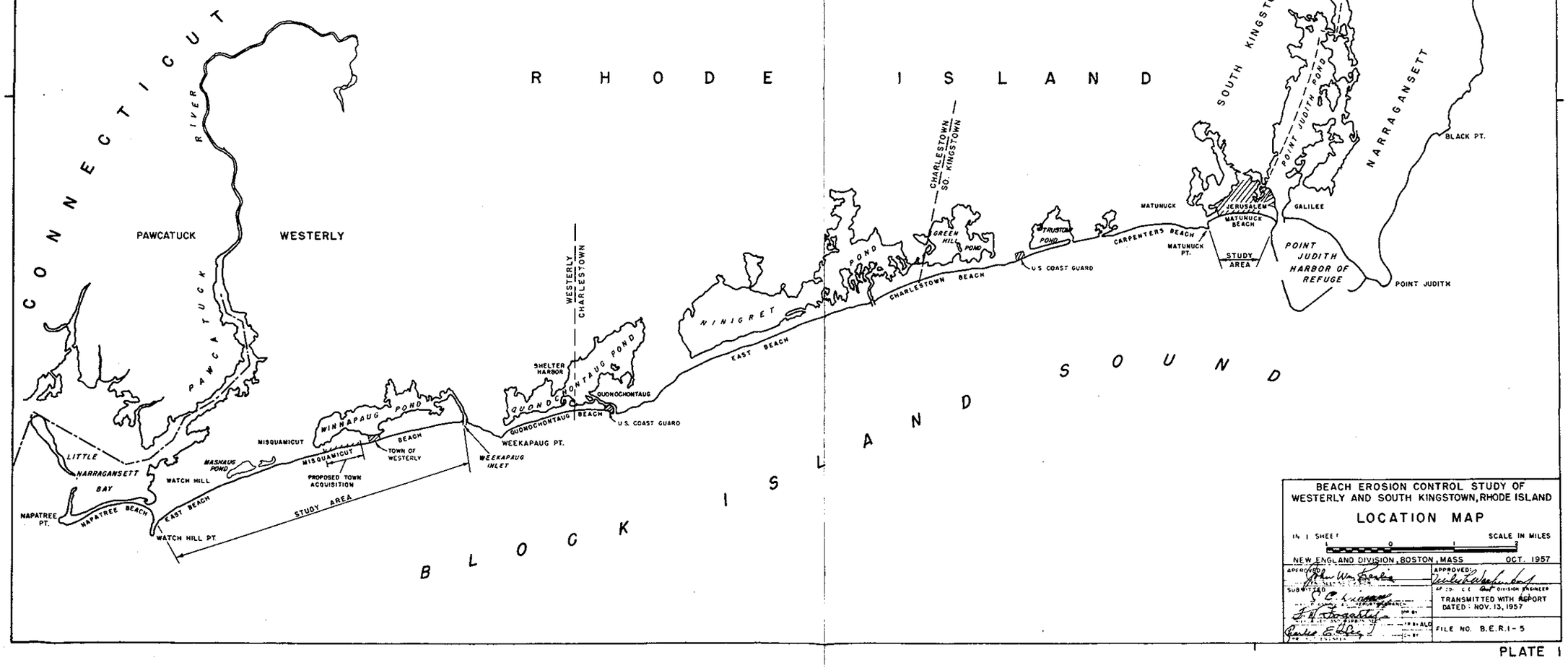


WIND ROSE

BLOCK ISLAND, RHODE ISLAND

BASED ON OBSERVATIONS OF U.S. WEATHER BUREAU 1921 - 1939

WINDS 32 MILES PER HOUR AND OVER IN OCCURRENCES PER YEAR (1936-1945)



BEACH EROSION CONTROL STUDY OF WESTERLY AND SOUTH KINGSTOWN, RHODE ISLAND

LOCATION MAP

IN 1 SHEET

SCALE IN MILES 1 0 1 2

NEW ENGLAND DIVISION, BOSTON, MASS OCT. 1957

APPROVED: Thos. W. Sprague

SUBMITTED: C. L. Cramer, Jr. CHIEF, ENGINEERING DIV.; J. H. Fogarty, CHIEF, PLANNING BRANCH; Charles E. Ely, CHIEF, DESIGN SECTION

APPROVED: Wilbur N. Glenn, Col. CE, DIVISION ENGINEER

TRANSMITTED WITH REPORT DATED: NOV. 13, 1957

FILE NO. B.E.R.I-5

PLATE 1

CORPS OF ENGINEERS

U.S. ARMY

E484,000 E486,000 E488,000 E490,000 E492,000 E494,000 E496,000 E498,000

N110,000 N108,000 N106,000 N104,000 N102,000

N

MATUNUCK

SEAWEED COVE

POTTER POND

POINT JUDITH POND

MATUNUCK POINT

WEST BREAKWATER

P-1 P-2 P-3 P-4 P-5

+0.3 +0.5 +10.3 +7.9 10.6 13.2 17.3 22.7 24.0 26.5 27.7 28.6 (4)

+2.1 +3.6 +5.5 9.8 10.1 13.9 16.5 16.5 17.6 16.5 17.3 15.7 15.8 16.4 14.9 16.5 15.7 17.3 21.7 22.3 24.0 25.2 26.7 26.3 26.8 26.5 27.6 27.8 (3)

+1.9 +3.5 +4.2 +7.4 15.0 16.1 16.0 16.7 19.1 20.0 20.9 23.9 24.6 25.1 26.3 26.9 27.1 26.7 26.8 (2)

+2.6 +4.4 +6.5 +6.9 10.3 13.5 15.3 16.5 18.7 18.5 21.4 21.6 22.7 24.3 26.8 25.6 23.4 22.5 22.5 24.2 25.2 27.4 26.6 27.0 26.7 28.6 (1)

NOTES:

Soundings, elevations and probings are in feet and tenths and are referred to the plane of Mean Sea Level, 1929 datum.

Hydrography from survey of June & July, 1956 by J. Rock.

Sand samples were taken at beach berm, mid-tide and 6, 12, 18, 24 and 30 foot depths, on Profiles 2, 3, 7, 9, 11 and 13.

Elevation of Mean Low Water is -1.5 feet at Pt. Judith and -1.0 feet at Watch Hill. Elevation of Mean High Water is +1.6 feet at Pt. Judith and +1.5 feet at Watch Hill.

1946 Mean High Water line is taken from Study on South Shore of Rhode Island, printed in H.D. No. 490, 81st Congress, 2nd Session.

Boring locations approximate; not located by instrument.

LIST OF PROBINGS

NUMBER	DEPTH OF WATER (ELEVATION BELOW MLW)	DEPTH OF PROBE (ELEVATION BELOW MLW)	PENETRATION	MATERIAL
1	1.2	6.2	5.0	Sand to mud
2	2.2	6.8	4.6	Do
3	2.2	7.2	5.0	Do
4	2.4	6.9	4.5	Do
5	1.4	7.3	5.9	Do

LEGEND

1956 M.H.W. SHORELINE

1946 M.H.W. SHORELINE

PROBINGS ● P-5

SAND SAMPLES ⊙

PROFILES (4)

BORINGS ◑ B 0-1

BEACH EROSION CONTROL STUDY OF WESTERLY AND SOUTH KINGSTOWN, RHODE ISLAND

SURVEY MAP

IN 3 SHEETS SCALE IN FEET 500 0 500 1000 SHEET 1

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 1957

SURVEYED: John Wm. Fowler

APPROVED: Fred Rehnquist, Lt. Col., C.E. Cmd. Division Engineer

SUBMITTED: E. Ringsmuth, Chief, Design Branch; F.W. Dougherty, Chief, Survey Branch; Carlos E. Day, Chief, Engineering Division

TRANSMITTED WITH REPORT DATED NOV. 13, 1957

FILE NO B.E.R.I.-6

PLATE 2

CORPS OF ENGINEERS — U.S. ARMY

E 416,000 | E 418,000 | E 420,000 | E 422,000 | E 424,000 | E 426,000 | E 428,000 | E 430,000

N 92,000 | N 90,000 | N 88,000 | N 86,000 | N 84,000

N

P O N D

P A U G A P A U G

W I N N

M I S Q U A M I C U T

A T L A N T I C A V E N U E

W E E K A P A U G

WEEKAPAUG POINT

BD-1 BD-2 BD-4 BD-5 BD-6

P-6 P-7 P-8

MATCH LINE SHEET NO. 3

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	ELEVATION BELOW M.L.W. DEPTH OF PROBE	PENETRATION	MATERIAL
6	3.3	7.3	4.0	Sand & mud to mud
7	2.2	9.3	7.1	Sand to mud
8	1.2	6.3	5.1	Sand to mud

GRAPHIC LOGS

SCALE IN FEET

5 0 5

BD-1 30 SEPT. 1957 — El. +8.0 ± — SP Brown Sand

BD-2 3 OCT. 1957 — El. 0.0 ± — Brown, silty, medium to fine Sand w/organic mat'l. (SM); Brown, slightly gravelly silty, very fine Sand (SM); Brown, gravelly Sand (SP-SM)

BD-3 4 OCT. 1957 — El. 0.0 ± — Brown, silty fine Sand (SP-SM); Grayish, brown, silty, gravelly very fine Sand (SM)

BD-4 9 OCT. 1957 — El. 0.0 ± — Gray, silty, fine to very fine Sand w/shell fragments (SP-SM); Gray, fine Sand (SP); Gray, silty, fine to very fine Sand (SP-SM)

BD-5 10 OCT. 1957 — El. 0.0 ± — Grayish brown med. to very fine silty Sand w/shell fragments (SM); Grayish brown, silty, fine to very fine Sand (SP-SM); Grayish brown, silty Sand w/organic material (SM)

BD-6 11 OCT. 1957 — El. +1.0 ± — Topsoil w/gross roots; Brown, slightly gravelly, silty Sand w/organic (SM); Gray, silty, fine to very fine Sand w/shell fragments (SP-SM); Gray, med. to very fine Sand (SP); Dark brown Silt (ML); Dark brown, silty sandy Gravel (Largely decomposed rock) (GP-GM)

LEGEND FOR GRAPHIC LOGS OF EXPLORATIONS

BD-1 — Type and number of exploration

30 SEPT. 1957 — Date exploration completed

El. +8.0 — Elevation of ground surface at time of exploration

0.0 — Depth in feet below ground surface

3.0 — Depth range of individual drive of sample spoon and outside diameter of sample spoon. (Wall thickness 1/4 inch)

40 — Number of blows per foot of penetration using a 350 pound hammer falling freely on average of 18 inches on the sample spoon of the size indicated and equipped with a beveled drive spoon.

Fractional foot of penetration indicated as follows: number of blows / Tenths of a foot (150/3)

SP — Group symbol according to Unified Soil Classification System.

Subsurface water level at time of exploration.

NOTE:
For notes, see Sheet 1.

BEACH EROSION CONTROL STUDY OF WESTERLY AND SOUTH KINGSTOWN, RHODE ISLAND

SURVEY MAP

IN 3 SHEETS — SCALE IN FEET 500 0 500 1000 — SHEET 2

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 1957

APPROVED: Arthur Wa Kesler, Lt. Col., C.E., Acting Division Engineer

SUBMITTED: C. Ryssum, Chief, Design Branch; J. H. Fogarty, Chief, Engineering Division; Charles E. Day, Project Engineer

TRANSMITTED WITH REPORT DATED NOV. 13, 1957

FILE NO. B.E.R.I.-6

PLATE 3

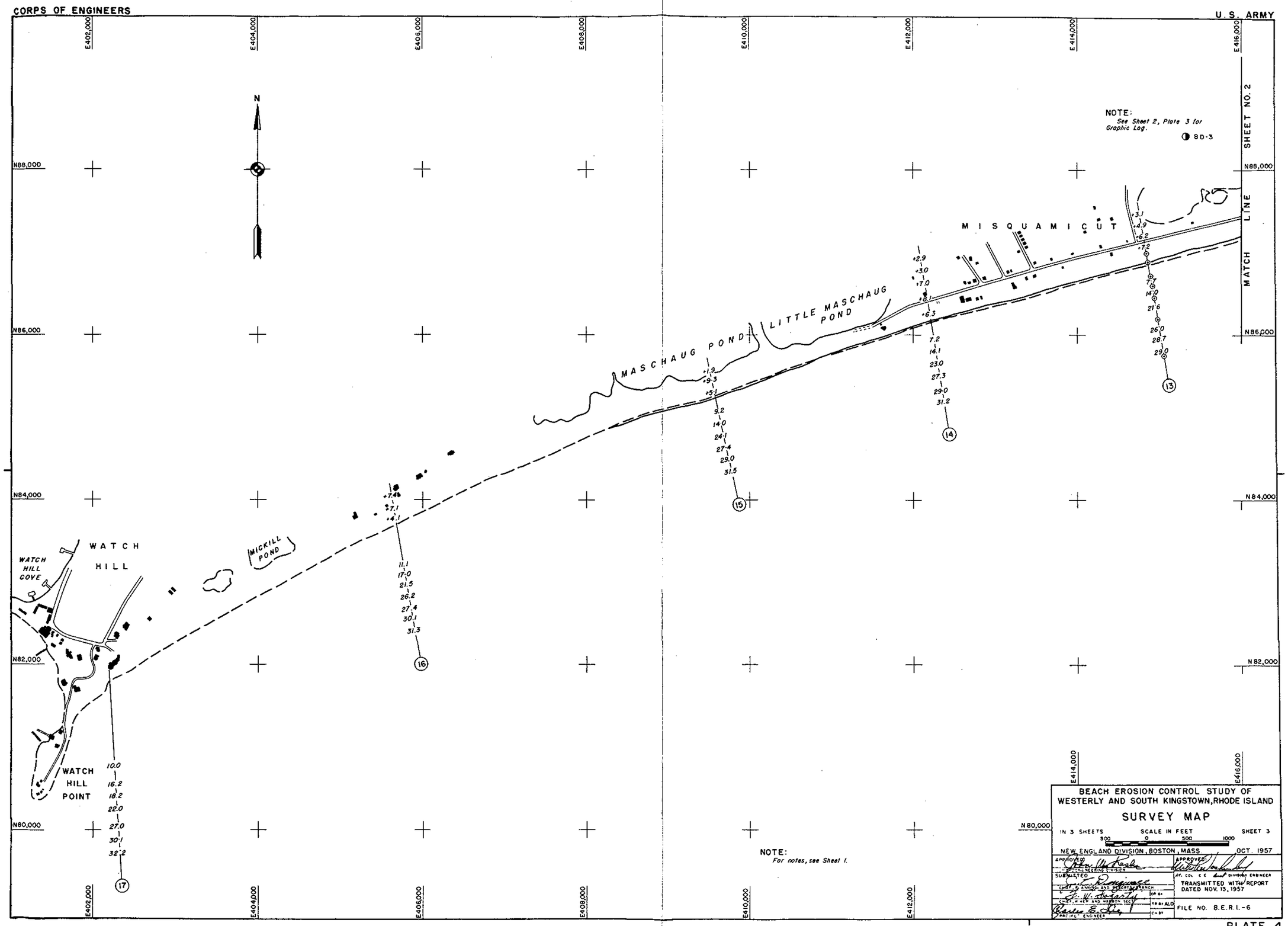
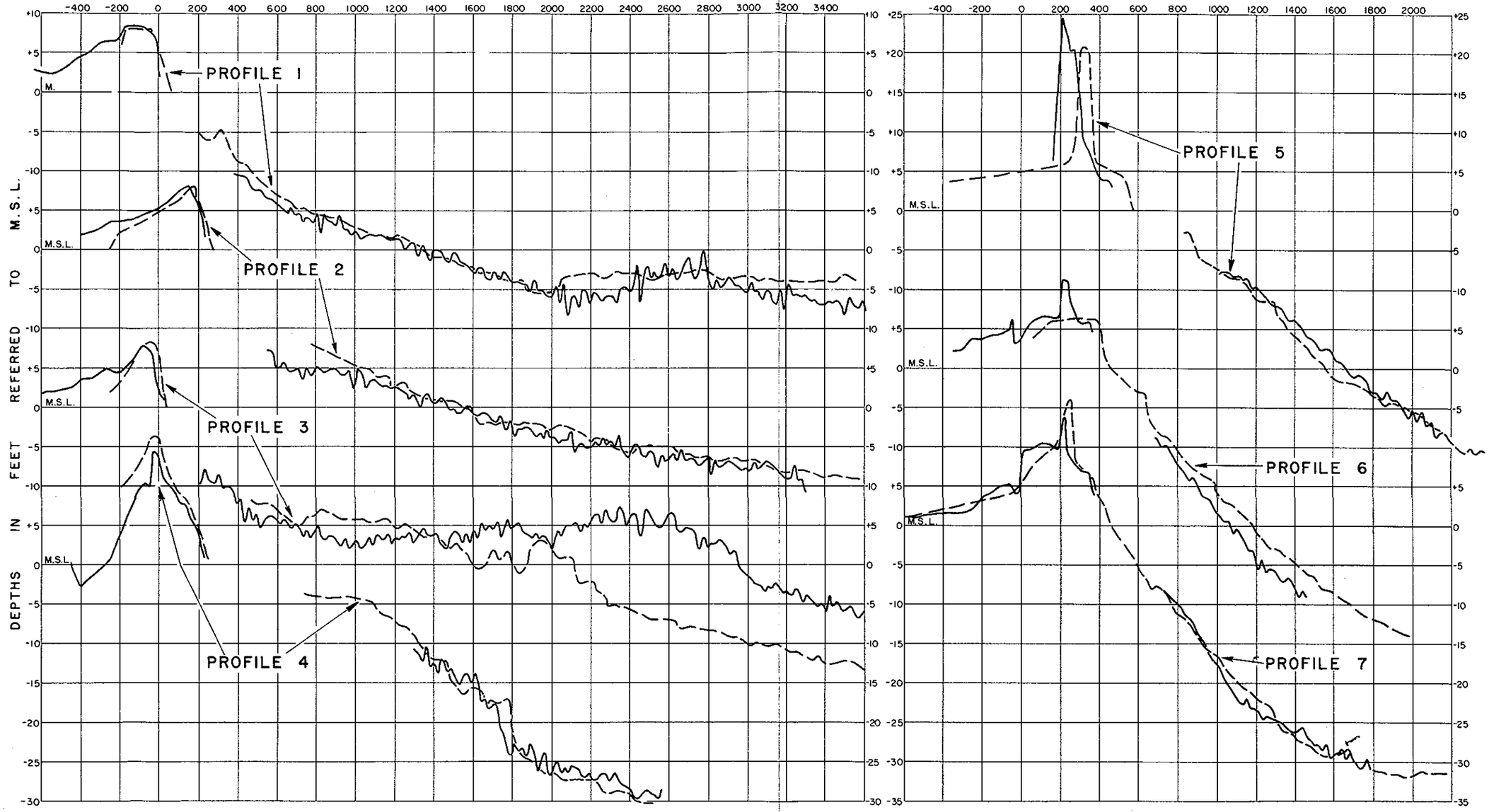

CORPS OF ENGINEERS
U.S. ARMY
E402,000
E404,000
E406,000
E408,000
E410,000
E412,000
E414,000
E416,000
N88,000
N86,000
N84,000
N82,000
N80,000
N
NOTE:
See Sheet 2, Plate 3 for Graphic Log.
8D-3
SHEET NO. 2
MATCH LINE
MISQUAMICUT
MASCHAUG POND
LITTLE MASCHAUG POND
MICKILL POND
WATCH HILL
WATCH HILL COVE
WATCH HILL POINT
NOTE:
For notes, see Sheet 1.
BEACH EROSION CONTROL STUDY OF
WESTERLY AND SOUTH KINGSTOWN, RHODE ISLAND
SURVEY MAP
IN 3 SHEETS
SCALE IN FEET
500 0 500 1000
SHEET 3
NEW ENGLAND DIVISION, BOSTON, MASS.
OCT. 1957
APPROVED:
SUBMITTED:
APPROVED:
TRANSMITTED WITH REPORT DATED NOV. 13, 1957
FILE NO. B.E.R.I.-6

PLATE 4

CORPS OF ENGINEERS

U.S. ARMY



LEGEND

——— JULY 1956

— — — AUG. 1946

NOTES:

Profiles by Corps of Engineers July 1956.

Elevations and depths are referred to Mean Sea Level, 1929 datum. At Profile 1-4, M.L.W. = -1.5 ft. and M.H.W. = +1.6 ft. At Profile 5-16, M.L.W. = -1.0 ft. and M.H.W. = +1.5 ft.

BEACH EROSION CONTROL STUDY OF WESTERLY AND SOUTH KINGSTOWN, RHODE ISLAND

COMPARATIVE PROFILES

IN 2 SHEETS — SCALE IN FEET — SHEET 1

HOR. 200 0 200 400 600

VER. 5 0 5 10 15

NEW ENGLAND DIVISION, BOSTON, MASS. — OCT. 1957

APPROVED: [signature]

SUBMITTED: [signature]

APPROVED: [signature] DIVISION ENGINEER

TRANSMITTED WITH REPORT DATED NOV. 13, 1957

FILE NO. B.E.R.I. 7

PLATE 5

CORPS OF ENGINEERS

U.S. ARMY

DISTANCES OUT FROM BASE LINE IN FEET

DEPTHS IN FEET REFERRED TO M.S.L.

PROFILE 8

PROFILE 9

PROFILE 10

PROFILE 11

PROFILE 12

PROFILE 13

PROFILE 14

PROFILE 15

PROFILE 16

M.S.L.

NOTE:
For notes, see Sheet 1.

BEACH EROSION CONTROL STUDY OF
WESTERLY AND SOUTH KINGSTOWN, RHODE ISLAND

COMPARATIVE PROFILES

IN 2 SHEETS — SCALE IN FEET — SHEET 2

NEW ENGLAND DIVISION, BOSTON, MASS. — OCT. 1957

SUBMITTED: Chief, Planning and Reports Branch

APPROVED: Chief Engineering Division

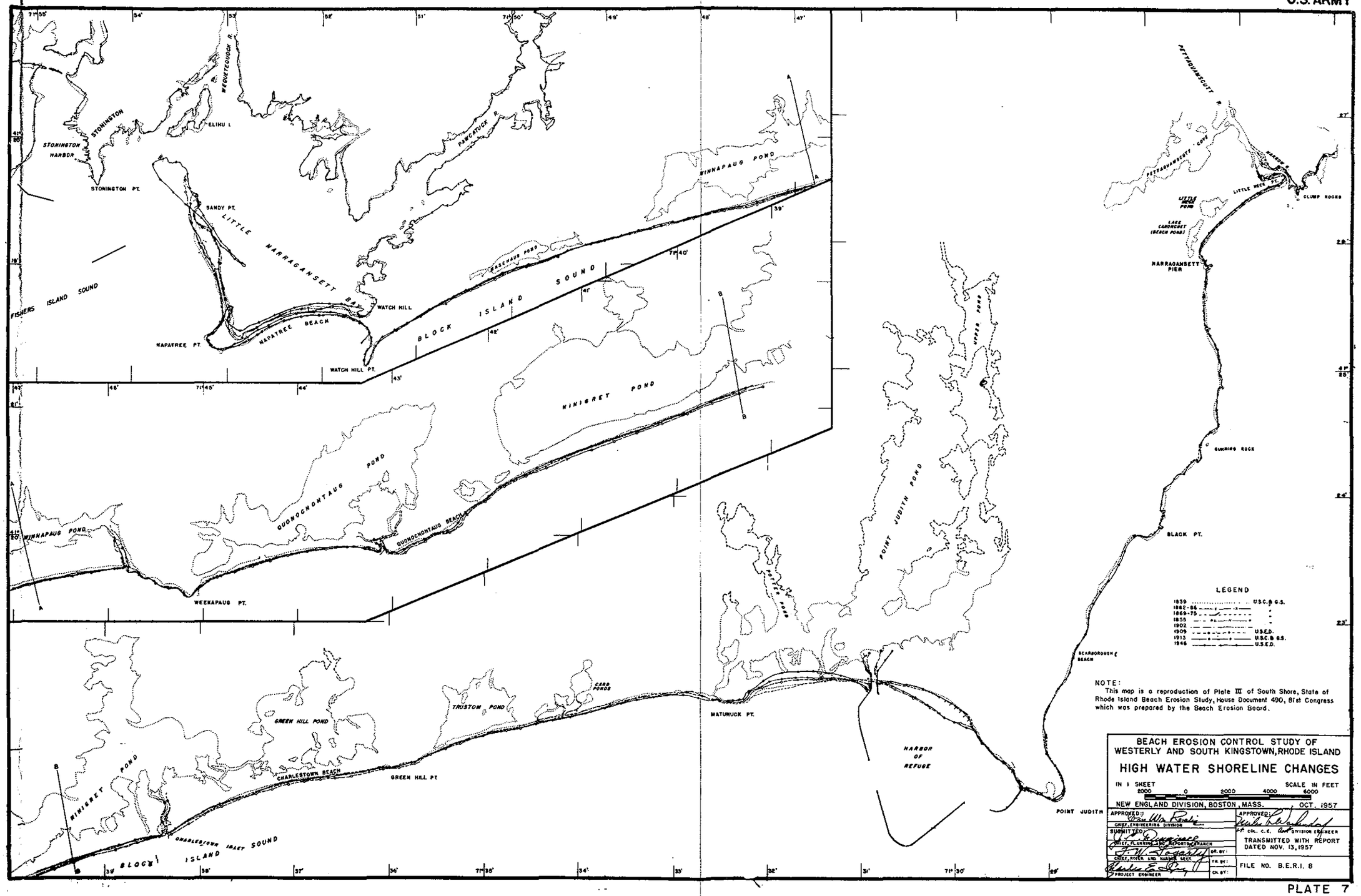
APPROVED: Acting Division Engineer

TRANSMITTED WITH REPORT DATED NOV. 13, 1957

FILE NO. B.E.R.I. 7

PLATE 6

U.S. ARMY



NOTE:
This map is a reproduction of Plate III of South Shore, State of Rhode Island Beach Erosion Study, House Document 490, 81st Congress which was prepared by the Beach Erosion Board.

BEACH EROSION CONTROL STUDY OF
WESTERLY AND SOUTH KINGSTOWN, RHODE ISLAND

HIGH WATER SHORELINE CHANGES

IN 1 SHEET
SCALE IN FEET
2000 0 2000 4000 6000

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 1957

APPROVED:
CHIEF, ENGINEERING DIVISION

SUBMITTED:
CHIEF, PLANNING & REPORTS BRANCH

CHIEF, RIVER AND HARBOR SECT.

PROJECT ENGINEER

APPROVED:
Lt. Col., C.E. Asst. DIVISION ENGINEER

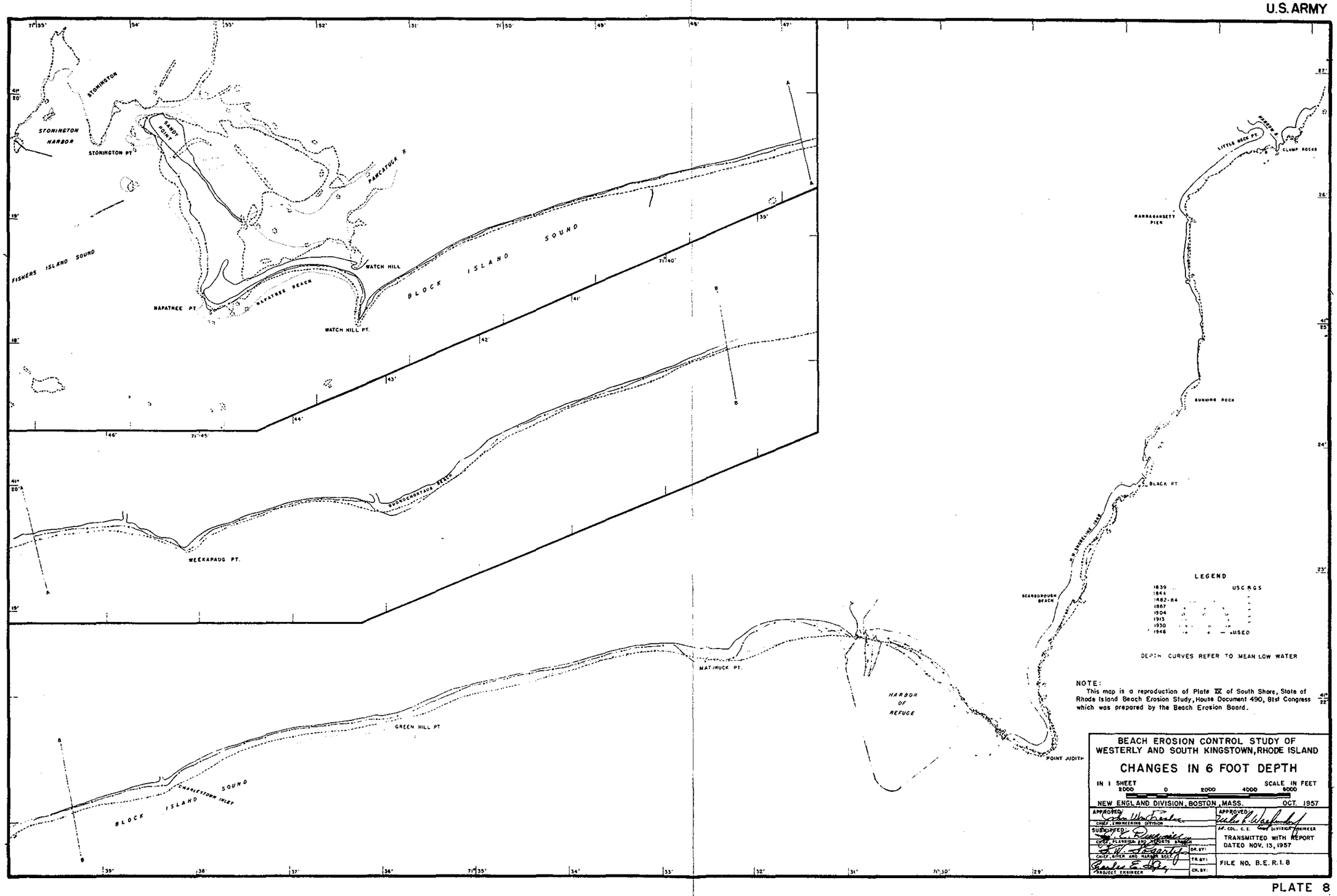
TRANSMITTED WITH REPORT DATED NOV. 13, 1957

DR. BY:
TR. BY:
CH. BY:

FILE NO. B.E.R.I. 8

PLATE 7

U.S. ARMY



LEGEND

	USC R G S
1839	
1844	
1882-84	
1887	
1904	
1915	
1930	
1946	— AUSED

DEPTH CURVES REFER TO MEAN LOW WATER

NOTE:
This map is a reproduction of Plate IX of South Shore, State of Rhode Island Beach Erosion Study, House Document 490, 81st Congress which was prepared by the Beach Erosion Board.

BEACH EROSION CONTROL STUDY OF WESTERLY AND SOUTH KINGSTOWN, RHODE ISLAND

CHANGES IN 6 FOOT DEPTH

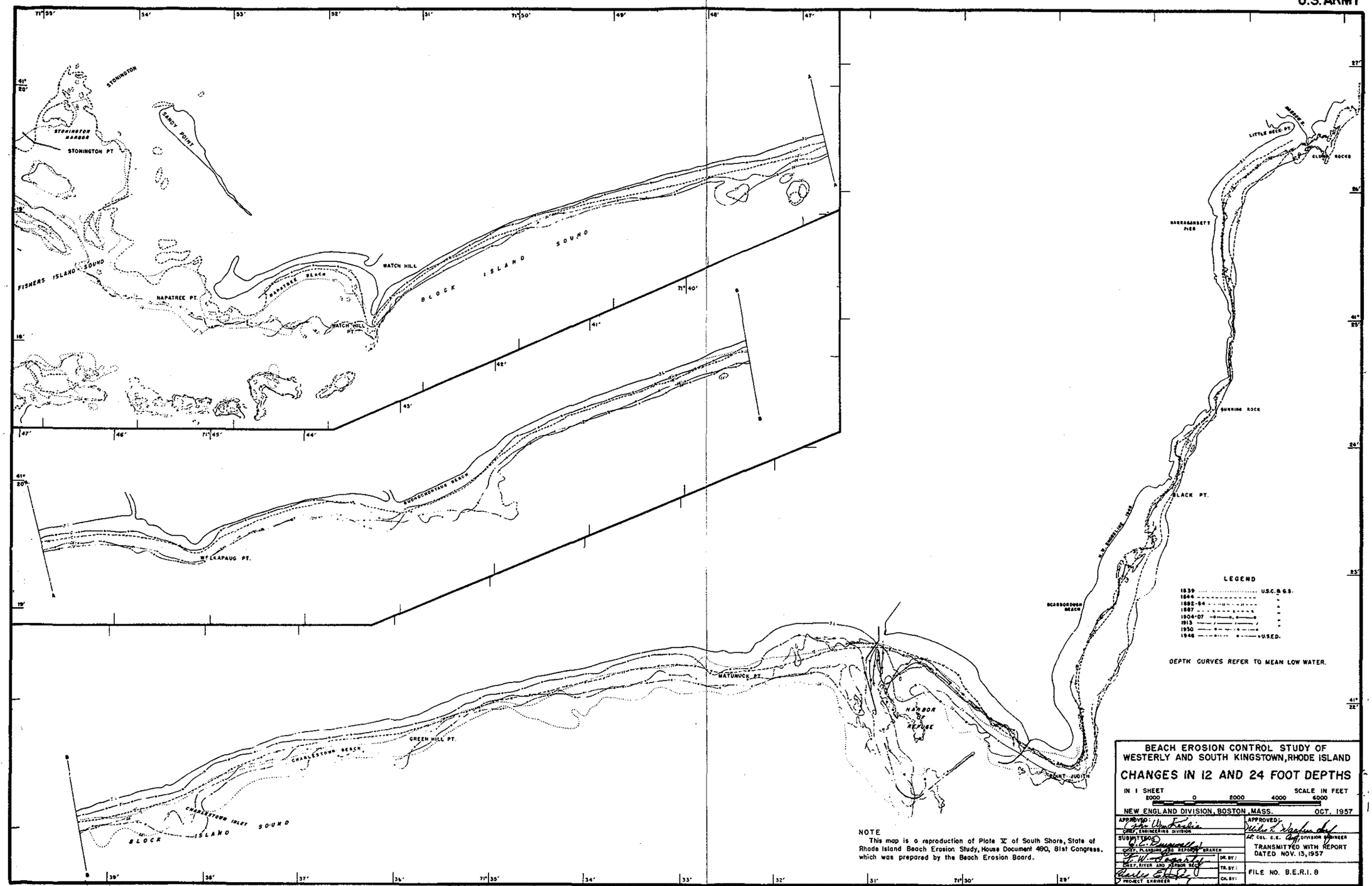
IN 1 SHEET — SCALE IN FEET 8000 0 2000 4000 8000

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 1957

APPROVED: Chief, Engineering Division	APPROVED: Lt. Col. C. E. Division Engineer
SUBMITTED: Chief, Planning and Reports Branch	TRANSMITTED WITH REPORT DATED NOV. 13, 1957
Chief, River and Harbor Sect. DR. BY:	
Project Engineer TR. BY: CH. BY:	FILE NO. B.E.R.I.8

PLATE 8

U.S. ARMY



NOTE
This map is a reproduction of Plate V of South Shore, State of Rhode Island Beach Erosion Study, House Document 490, 81st Congress, which was prepared by the Beach Erosion Board.

BEACH EROSION CONTROL STUDY OF WESTERLY AND SOUTH KINGSTOWN, RHODE ISLAND

CHANGES IN 12 AND 24 FOOT DEPTHS

IN 1 SHEET — SCALE IN FEET: 2000 0 2000 4000 6000

NEW ENGLAND DIVISION, BOSTON, MASS. — OCT. 1957

APPROVED: CHIEF, ENGINEERING DIVISION

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

CHIEF, RIVER AND HARBOR SECT.

PROJECT ENGINEER

DR. BY:

TR. BY:

CH. BY:

APPROVED: Lt. COL. C.E. Chief, DIVISION ENGINEER

TRANSMITTED WITH REPORT DATED NOV. 13, 1957

FILE NO. B.E.R.I. 8

PLATE 9

U.S. ARMY

NOTE:
This map is a reproduction of Plate VI of South Shore, State of Rhode Island Beach Erosion Study, House Document 490, 81st Congress which was prepared by the Beach Erosion Board.

BEACH EROSION CONTROL STUDY OF WESTERLY AND SOUTH KINGSTOWN, RHODE ISLAND

CHANGES IN 18 AND 30 FOOT DEPTHS

IN 1 SHEET — SCALE IN FEET 2000 0 2000 4000 6000

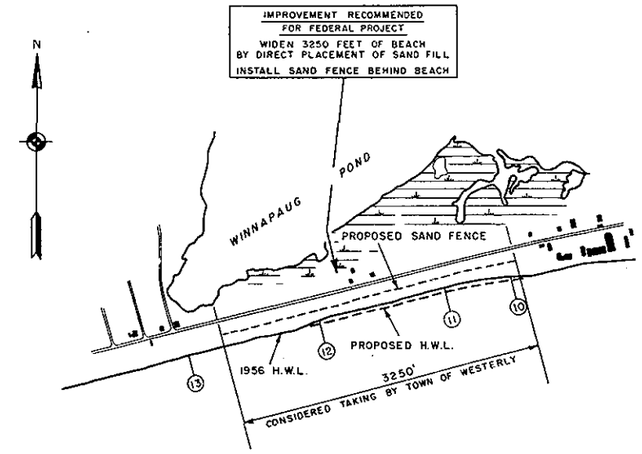
NEW ENGLAND DIVISION, BOSTON, MASS. OCT 1957

APPROVED: CHIEF, ENGINEERING DIVISION	APPROVED: LT. COL. C.E. DIVISION ENGINEER
SUBMITTED: CHIEF, PLANNING & REPORTS BRANCH	TRANSMITTED WITH REPORT DATED NOV. 13, 1957
DR. BY:	
CHIEF, RIVER AND HARBOR ACT	TR. BY:
PROJECT ENGINEER	CH. BY
	FILE NO. B.E.R.I. 8

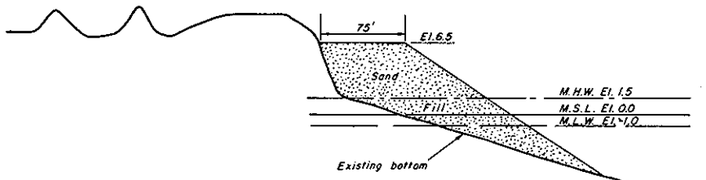
PLATE 10

CORPS OF ENGINEERS

U.S. ARMY



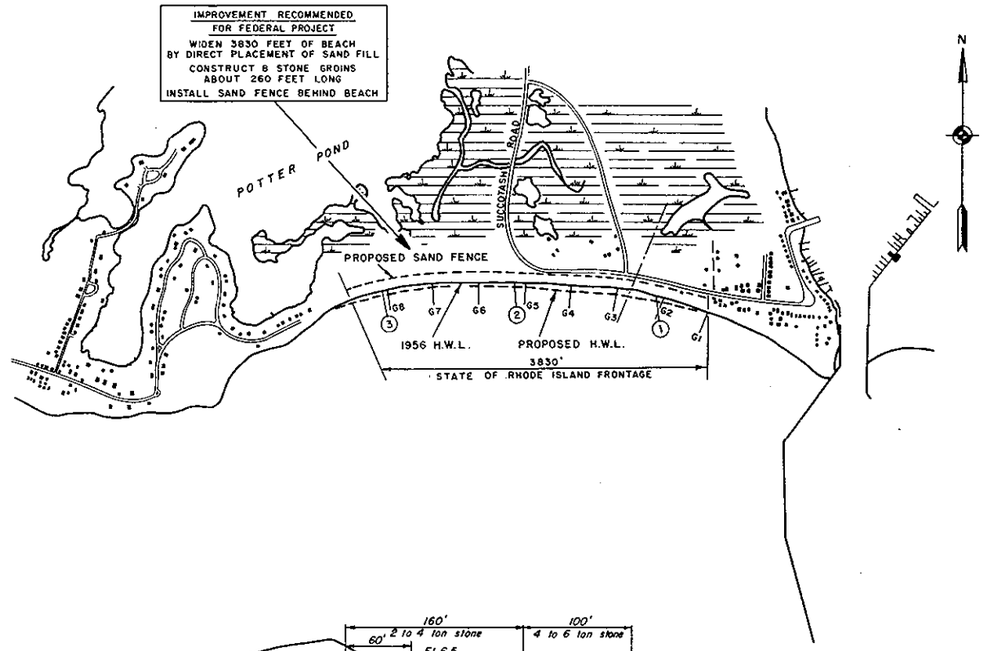
PROPOSED SAND FILL - PROFILE 11



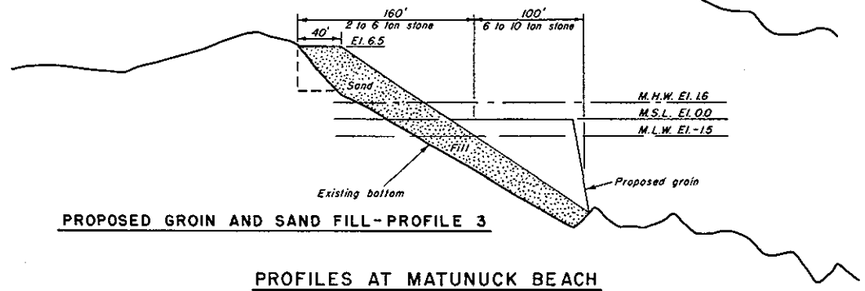
PROPOSED SAND FILL - PROFILE 12

PROFILES AT MISQUAMICUT BEACH

HOR. 50 0 50 100
VER. 5 0 5 10



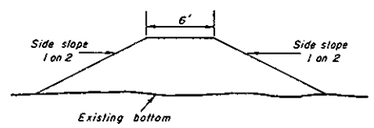
PROPOSED GROIN AND SAND FILL - PROFILE 2



PROPOSED GROIN AND SAND FILL - PROFILE 3

PROFILES AT MATUNUCK BEACH

HOR. 50 0 50 100
VER. 5 0 5 10



TYPICAL GROIN SECTION

5 0 5 10

NOTES:
Elevations are referred to M.S.L. 1929 datum.
Shorelines are from 1956 aerial photos.

LEGEND

GROINS SHOWN THUS —— G1
PROFILES SHOWN THUS —(3)

BEACH EROSION CONTROL STUDY OF
WESTERLY AND SOUTH KINGSTOWN, RHODE ISLAND

PLAN OF IMPROVEMENTS

IN 1 SHEET — SCALE IN FEET 1000 0 1000 2000

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 1957

APPROVED: Wm. Kuhl
CHIEF, ENGINEERING DIVISION

SUBMITTED: P. Benjamin
CHIEF, PLANNING AND REPORTS BRANCH

E. W. Stegerly
CHIEF, RIVER AND HARBOR SECT.

Charles E. Hall
PROJECT ENGINEER

APPROVED: Clifford L. Bamford
COL., C.E. and DIVISION ENGINEER

TRANSMITTED WITH REPORT DATED: NOV. 13, 1957

DR BY
T.B. BY ALD
CH BY

FILE NO. B.E.R.I. 9

PLATE 11